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JOURNAL OF THE ROYAL MICROSCOPICAL SOCIETY;

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS,

AND A SUMMARY OF CURRENT RESEARCHES RELATING TO
ZOOLOGY AND BOTANY
(principally Invertebrata and Cryptogamia),
MICROSCOPY, &c.

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(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.

Edited by

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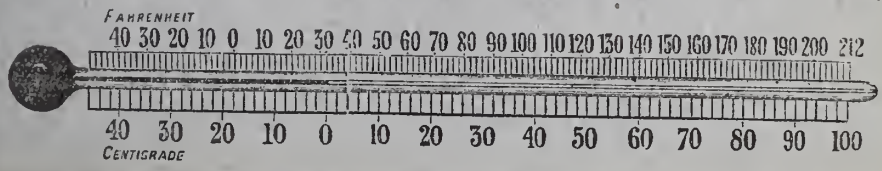
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APERTURE TABLE.

Numerical Aperture. ($n \sin u = a$.)	Corresponding Angle (2u) for			Limit of Resolving Power, in Lines to an Inch.			Illuminating Power. (a^2 .)	Penetrating Power ($\frac{1}{a}$)
	Air ($n = 1.00$.)	Water ($n = 1.33$.)	Homogeneous Immersion ($n = 1.52$.)	White Light. ($\lambda = 0.5269 \mu$, Line E.)	Monochromatic (Blue) Light. ($\lambda = 0.4861 \mu$, Line F.)	Photography. ($\lambda = 0.4000 \mu$, Near Line A.)		
1.52	..	..	180° 0'	146,543	158,845	193,037	2.310	•658
1.51	..	..	166° 51'	145,579	157,800	191,767	2.280	•662
1.50	..	..	161° 23'	144,615	156,755	190,497	2.250	•667
1.49	..	..	157° 12'	143,651	155,710	189,227	2.220	•671
1.48	..	..	153° 39'	142,687	154,665	187,957	2.190	•676
1.47	..	..	150° 32'	141,723	153,620	186,687	2.161	•680
1.46	..	..	147° 42'	140,759	152,575	185,417	2.132	•685
1.45	..	..	145° 6'	139,795	151,530	184,147	2.103	•690
1.44	..	..	142° 39'	138,830	150,485	182,877	2.074	•694
1.43	..	..	140° 22'	137,866	149,440	181,607	2.045	•694
1.42	..	..	138° 12'	136,902	148,395	180,337	2.016	•709
1.41	..	..	136° 8'	135,938	147,350	179,067	1.988	•709
1.40	..	..	134° 10'	134,974	146,305	177,797	1.960	•714
1.39	..	..	132° 16'	134,010	145,260	176,527	1.932	•719
1.38	..	..	130° 26'	133,046	144,215	175,257	1.904	•725
1.37	..	..	128° 40'	132,082	143,170	173,987	1.877	•729
1.36	..	..	126° 58'	131,118	142,125	172,717	1.850	•735
1.35	..	..	125° 18'	130,154	141,080	171,447	1.823	•741
1.34	..	..	123° 40'	129,189	140,035	170,177	1.796	•746
1.33	..	180° 0'	122° 6'	128,225	138,989	168,907	1.769	•752
1.32	..	165° 56'	120° 33'	127,261	137,944	167,637	1.742	•758
1.30	..	155° 38'	117° 35'	125,333	135,854	165,097	1.690	•769
1.28	..	148° 42'	114° 44'	123,405	133,764	162,557	1.638	•781
1.26	..	142° 39'	111° 59'	121,477	131,674	160,017	1.588	•794
1.24	..	137° 36'	109° 20'	119,548	129,584	157,477	1.538	•806
1.22	..	133° 4'	106° 45'	117,620	127,494	154,937	1.488	•820
1.20	..	128° 55'	104° 15'	115,692	125,404	152,397	1.440	•833
1.18	..	125° 3'	101° 50'	113,764	123,314	149,857	1.392	•847
1.16	..	121° 26'	99° 29'	111,835	121,224	147,317	1.346	•862
1.14	..	118° 0'	97° 11'	109,907	119,134	144,777	1.300	•877
1.12	..	114° 44'	94° 55'	107,979	117,044	142,237	1.254	•893
1.10	..	111° 36'	92° 43'	106,051	114,954	139,698	1.210	•909
1.08	..	108° 36'	90° 34'	104,123	112,864	137,158	1.166	•926
1.06	..	105° 42'	88° 27'	102,195	110,774	134,618	1.124	•943
1.04	..	102° 53'	86° 21'	100,266	108,684	132,078	1.082	•962
1.02	..	100° 10'	84° 18'	98,338	106,593	129,538	1.040	•980
1.00	180° 0'	97° 31'	82° 17'	96,410	104,503	126,998	1.000	1.000
0.98	157° 2'	94° 56'	80° 17'	94,482	102,413	124,458	•960	1.020
0.96	147° 29'	92° 24'	78° 20'	92,554	100,323	121,918	•922	1.042
0.94	140° 6'	89° 56'	76° 24'	90,625	98,223	119,378	•884	1.064
0.92	133° 51'	87° 32'	74° 30'	88,697	96,143	116,838	•846	1.087
0.90	128° 19'	85° 10'	72° 36'	86,769	94,053	114,298	•810	1.111
0.88	123° 17'	82° 51'	70° 44'	84,841	91,963	111,758	•774	1.136
0.86	118° 38'	80° 34'	68° 54'	82,913	89,873	109,218	•740	1.163
0.84	114° 17'	78° 20'	67° 6'	80,984	87,783	106,678	•706	1.190
0.82	110° 10'	76° 8'	65° 18'	79,056	85,693	104,138	•672	1.220
0.80	106° 16'	73° 58'	63° 31'	77,128	83,603	101,598	•640	1.250
0.78	102° 31'	71° 49'	61° 45'	75,200	81,513	99,058	•608	1.282
0.76	98° 56'	69° 42'	60° 0'	73,272	79,423	96,518	•578	1.316
0.74	95° 28'	67° 37'	58° 16'	71,343	77,333	93,979	•548	1.351
0.72	92° 6'	65° 32'	56° 32'	69,415	75,242	91,439	•518	1.389
0.70	88° 51'	63° 31'	54° 50'	67,487	73,152	88,899	•490	1.429
0.68	85° 44'	61° 30'	53° 9'	65,559	71,062	86,359	•462	1.471
0.66	82° 36'	59° 30'	51° 28'	63,631	68,972	83,819	•436	1.515
0.64	79° 36'	57° 31'	49° 48'	61,702	66,882	81,279	•410	1.562
0.62	76° 38'	55° 34'	48° 9'	59,774	64,792	78,739	•384	1.613
0.60	73° 44'	53° 38'	46° 30'	57,846	62,702	76,199	•360	1.667
0.58	70° 54'	51° 42'	44° 51'	55,918	60,612	73,659	•336	1.724
0.56	68° 6'	49° 48'	43° 14'	53,990	58,522	71,119	•314	1.776
0.54	65° 22'	47° 54'	41° 37'	52,061	56,432	68,579	•292	1.852
0.52	62° 40'	46° 2'	40° 0'	50,133	54,342	66,039	•270	1.923
0.50	60° 0'	44° 10'	38° 24'	48,205	52,252	63,499	•250	2.000
0.45	53° 30'	39° 33'	34° 27'	43,385	47,026	57,149	•203	2.222
0.40	47° 9'	35° 0'	30° 31'	38,564	41,801	50,799	•160	2.500
0.35	40° 58'	30° 30'	26° 38'	33,744	36,576	44,449	•123	2.857
0.30	34° 56'	26° 4'	22° 46'	28,923	31,351	38,099	•090	3.333
0.25	28° 58'	21° 40'	18° 56'	24,103	26,126	31,749	•063	4.000
0.20	23° 4'	17° 18'	15° 7'	19,282	20,901	25,400	•040	5.000
0.15	17° 14'	12° 58'	11° 19'	14,462	15,676	19,050	•023	6.667
0.10	11° 29'	8° 38'	7° 34'	9,641	10,450	12,700	•010	10.000
0.05	5° 44'	4° 18'	3° 46'	4,821	5,252	6,350	•003	20.000

COMPARISON OF THE FAHRENHEIT AND CENTIGRADE THERMOMETERS.

Fahr.	Centigr.	Fahr.	Centigr.	Fahr.	Centigr.	Fahr.	Centigr.	Fahr.	Centigr.
°	°	°	°	°	°	°	°	°	°
212	100	158	70	104	40	50	10	- 4	- 20
210·2	99	156·2	69	102·2	39	48·2	9	- 5·8	- 21
210	98·89	156	68·89	102	38·89	48	8·89	- 6	- 21·11
208·4	98	154·4	68	100·4	38	46·4	8	- 7·6	- 22
208	97·78	154	67·78	100	37·78	46	7·78	- 8	- 22·22
206·6	97	152·6	67	98·6	37	44·6	7	- 9·4	- 23
206	96·67	152	66·67	98	36·67	44	6·67	- 10	- 23·33
204·8	96	150·8	66	96·8	36	42·8	6	- 11·2	- 24
204	95·56	150	65·56	96	35·56	42	5·56	- 12	- 24·44
203	95	149	65	95	35	41	5	- 13	- 25
202	94·44	148	64·44	94	34·44	40	4·44	- 14	- 25·56
201·2	94	147·2	64	93·2	34	39·2	4	- 14·8	- 26
200	93·33	146	63·33	92	33·33	38	3·33	- 16	- 26·67
199·4	93	145·4	63	91·4	33	37·4	3	- 16·6	- 27
198	92·22	144	62·22	90	32·22	36	2·22	- 18	- 27·78
197·6	92	143·6	62	89·6	32	35·6	2	- 18·4	- 28
196	91·11	142	61·11	88	31·11	34	1·11	- 20	- 28·89
195·8	91	141·8	61	87·8	31	33·8	1	- 20·2	- 29
194	90	140	60	86	30	32	0	- 22	- 30
192·2	89	138·2	59	84·2	29	30·2	- 1	- 23·8	- 31
192	88·89	138	58·89	84	28·89	30	- 1·11	- 24	- 31·11
190·4	88	136·4	58	82·4	28	28·4	- 2	- 25·6	- 32
190	87·78	136	57·78	82	27·78	28	- 2·22	- 26	- 32·22
188·6	87	134·6	57	80·6	27	26·6	- 3	- 27·4	- 33
188	86·67	134	56·67	80	26·67	26	- 3·33	- 28	- 33·33
186·8	86	132·8	56	78·8	26	24·8	- 4	- 29·2	- 34
186	85·56	132	55·56	78	25·56	24	- 4·44	- 30	- 34·44
185	85	131	55	77	25	23	- 5	- 31	- 35
184	84·44	130	54·44	76	24·44	22	- 5·56	- 32	- 35·56
183·2	84	129·2	54	75·2	24	21·2	- 6	- 32·8	- 36
182	83·33	128	53·33	74	23·33	20	- 6·67	- 34	- 36·67
181·4	83	127·4	53	73·4	23	19·4	- 7	- 34·6	- 37
180	82·22	126	52·22	72	22·22	18	- 7·78	- 36	- 37·78
179·6	82	125·6	52	71·6	22	17·6	- 8	- 36·4	- 38
178	81·11	124	51·11	70	21·11	16	- 8·89	- 38	- 38·89
177·8	81	123·8	51	69·8	21	15·8	- 9	- 38·2	- 39
176	80	122	50	68·2	20	14	- 10	- 40	- 40
174·2	79	120·2	49	66	19	12·2	- 11	- 41·80	- 41
174	78·89	120	48·89	66·4	18·89	12	- 11·11	- 42	- 41·11
172·4	78	118·4	48	64	18	10·4	- 12	- 43·60	- 42
172	77·78	118	47·78	64·6	17·78	10	- 12·22	- 44	- 42·22
170·6	77	116·6	47	62	17	8·6	- 13	- 45·40	- 43
170	76·67	116	46·67	62·8	16·67	8	- 13·33	- 46	- 43·33
168·8	76	114·8	46	60	16	6·8	- 14	- 47·20	- 44
168	75·56	114	45·56	60	15·56	6	- 14·44	- 48	- 44·44
167	75	113	45	59	15	5	- 15	- 49	- 45
166	74·44	112	44·44	58	14·44	4	- 15·56	- 50	- 45·56
165·2	74	111·2	44	57·2	14	3·2	- 16	- 50·80	- 46
164	73·33	110	43·33	56	13·33	2	- 16·67	- 52	- 46·67
163·4	73	109·4	43	55·4	13	1·4	- 17	- 52·60	- 47
162	72·22	108	42·22	54	12·22	0	- 17·78	- 54	- 47·78
161·6	72	107·6	42	53·6	12	- 0·4	- 18	- 54·40	- 48
160	71·11	106	41·11	52	11·11	- 2	- 18·89	- 56	- 48·89
159·8	71	105·8	41	51·8	11	- 2·2	- 19	- 56·20	- 49
								- 58	- 50



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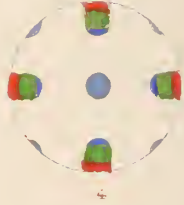
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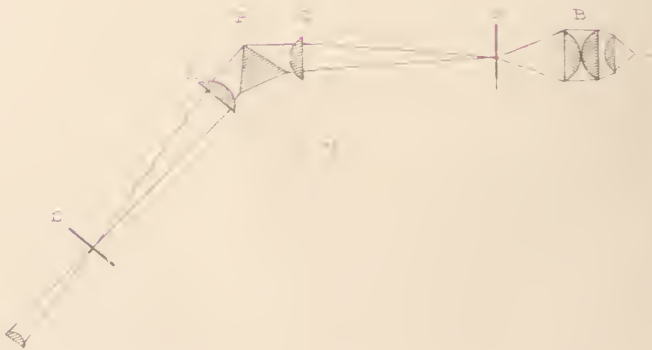
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JOURNAL OF THE ROYAL MICROSCOPICAL SOCIETY.

FEBRUARY 1892.

TRANSACTIONS OF THE SOCIETY.

I.—*Further Notes on the Monochromatic Illuminating Apparatus.*

By E. M. NELSON, F.R.M.S.

(Read 18th November, 1891.)

PLATE I.

SINCE my former paper on the subject I have made critical experiments with this method of illumination, the result being that I am so impressed with the advantages gained by the method that for all delicate work I intend to use it exclusively.

The accompanying diagrams illustrate wherein the efficacy of monochromatic illumination by prism dispersion excels that by absorption media. Fig. 1 shows the spectrum at the back of a 1½-in. apochromatic objective, as seen when the eye-piece is removed, the object on the stage being a *P. formosum*, and the illumination a small cone of monochromatic red light, as in this case it is the spectra and not the object we require to examine.

The figure shows that we have a dioptric beam of monochromatic red light surrounded by four half-discs of red spectra of the first order.

Fig. 2 shows that, with precisely the same conditions, if we substitute monochromatic green light for the red we shall bring in the whole of the inner four spectra of the first order.

Fig. 3 shows the same thing with blue light substituted for green. We have now nearly half of the outer four spectra of the first order brought within the grip of the objective.

Fig. 4 shows the same object under the same conditions illuminated by so-called monochromatic blue light, obtained by absorption media. The red in the spectrum is still conspicuous. The blue edges of the four outlying spectra of the first order are apparently not brought so far within the grip of the objective. Theoretically they are of course precisely in the same position as in the other case, fig. 3, but practically they are not so conspicuous because of the existence of other kinds of light. Be that as it may, it stands to reason that they can have no possible visual effect in the presence of the much more powerful visual exciting rays such as orange and yellow-green.

[Mr. Haughton Gill has called my attention to the Zeltnow
1892.

absorption medium,* which yields very approximately monochromatic yellow-green light (λ 560). It is a very simple and agreeable medium for visual work, and at the same time it greatly improves the definition of ordinary achromatic objectives. It must be remembered that as it only passes light low down the spectrum it will not increase the resolving power of an objective. The spectra are not quite so far in as those in fig. 2, and they are, moreover, tinged with blue on their inner, and with red on their outer edges.] †

I have not given a figure to show the spectra under the conditions of ordinary lamp-light illumination because it would be very similar to fig. 4; the only difference being that the dioptric beam would be white, the red would be a little brighter, and the blue a little dimmer than in fig. 4. In ordinary illumination the visual image is composed of neither the red nor the blue, but is that of rays such as orange and green. The advantage of the interposition of blue absorption media is due to the fact that the image-forming rays are sent higher up the spectrum, and consist of yellow and bluish-green. Any one carefully inspecting these figures will be convinced of the decided advantage gained by the use of monochromatic blue light. It will be noticed that I have adhered to Abbe's old nomenclature with regard to the spectra.

Before closing I will give a few words on the management of the apparatus and refer to fig. 7. The bull's-eye B will be found of great service as it requires great intensity of light to give a satisfactory illumination with the blue. The bull's-eye B should be attached to the lamp L, and the two first planos should be adjusted for parallel light before the third lens, the one remote from the lamp, is placed in position. In order to place the bull's-eye and lamp in a proper position with regard to the slit in the screen S, a piece of white card should be held in front of the prism P, and the light adjusted on it. It will then be easily seen if the prism P is evenly illuminated by the strongest part of the beam, and also whether the lamp and the bull's-eye are at a proper distance from the screen S.

The prism P should be of dense flint, as crown does not give sufficient dispersion. Very great care must be taken to place the prism P at minimum deviation. This is best accomplished by causing the spectrum to fall on the screen D when the lens R is turned out of the way. The prism is now rotated on its axis, and it will be seen that the spectrum on the screen D moves so that the angle D P S becomes either more obtuse or more acute. When the angle D P S is greatest, then the prism is at minimum deviation. The point where the centre of the spectrum falls on the screen D should now be noted. The lens R should next be turned into such a position that the spectrum may be in the same place as before. It is advisable to again move the prism, noticing particularly the slightest movements of the spectrum on the screen D to insure the deviation being at a minimum.

* See this Journal, 1889, pp. 133, 700.

† Added January 20th, 1892.

With regard to the management of the Microscope, the adjustments of the substage condenser for centering, &c., are precisely similar to those when a lamp is used in the ordinary way. In this case the slit in the screen D takes the place of the lamp-flame. When the condenser has been centered and the slit in the screen D brought to the centre of the field, the whole of the Microscope (or mirror if one is used) will probably require some movement before any light appears in the slit in the screen D. Even after the light has been obtained it will not be sufficient that the image of the lens R appears in the slit as in fig. 5, but it should be accurately centered by moving the whole Microscope until it is seen as in fig. 6.

I have placed another lens Q equal in focus to R on the other side of the prism P, which enables one with a more compact apparatus to obtain a spectrum the width of which equals the length of the slit, because the slits in the screens S and D are placed at the principal foci of the lenses, instead of double that distance as before. This plan also secures a more powerful illumination which enables work to be carried on deeper down into the blue. It is important that the screen D should be placed accurately in the focus of the lens R. It is a good plan to test the quality of the light by holding a white card between C and D before adjusting the Microscope. The size of the pencil after emergence from the screen D should be noted, and care should be exercised to see that the rays fill the back lens C of the substage condenser.

I have found that there is a considerable gain if the instrument is used direct, in other words the mirror abolished and the axis of the Microscope placed centrally in the pencil emerging from the screen D. To set this up is more troublesome, but by returning to my former wooden model it becomes easy. The whole apparatus, including the Microscope, stands on a plank of wood or base-board, but the lamp L, the bull's-eye B, the screen S, the lens Q, the prism P, and the lens R, are attached to another board which is pivoted on the base-board, and which is made capable of a slight rotation about the point P. The screen S and the second lens Q are fixed, and the prism P, which is on a turn-table, has a clamping screw so that it also may be fixed when the position for minimum deviation has been determined.

The lens R is as before capable of rotation about P, and it is likewise fitted with a clamping screw. The screen D is, however, fixed to the base-board on which the Microscope stands. The reason for this is that instead of moving the lens R in order to cause the movement of the spectrum across the slit in the screen D, which tends rather to disturb the adjustments, the whole board is rotated about its pivot P, and the light of the required colour brought in a line with the slit D. The whole apparatus is capable of being inclined to suit the inclination of the Microscope.

II.—*Freshwater Algæ and Schizophyceæ of South-west Surrey.*

By ALFRED W. BENNETT, M.A., B.Sc., V.P.L.S., V.P.R.M.S.,
Lecturer on Botany at St. Thomas's Hospital.

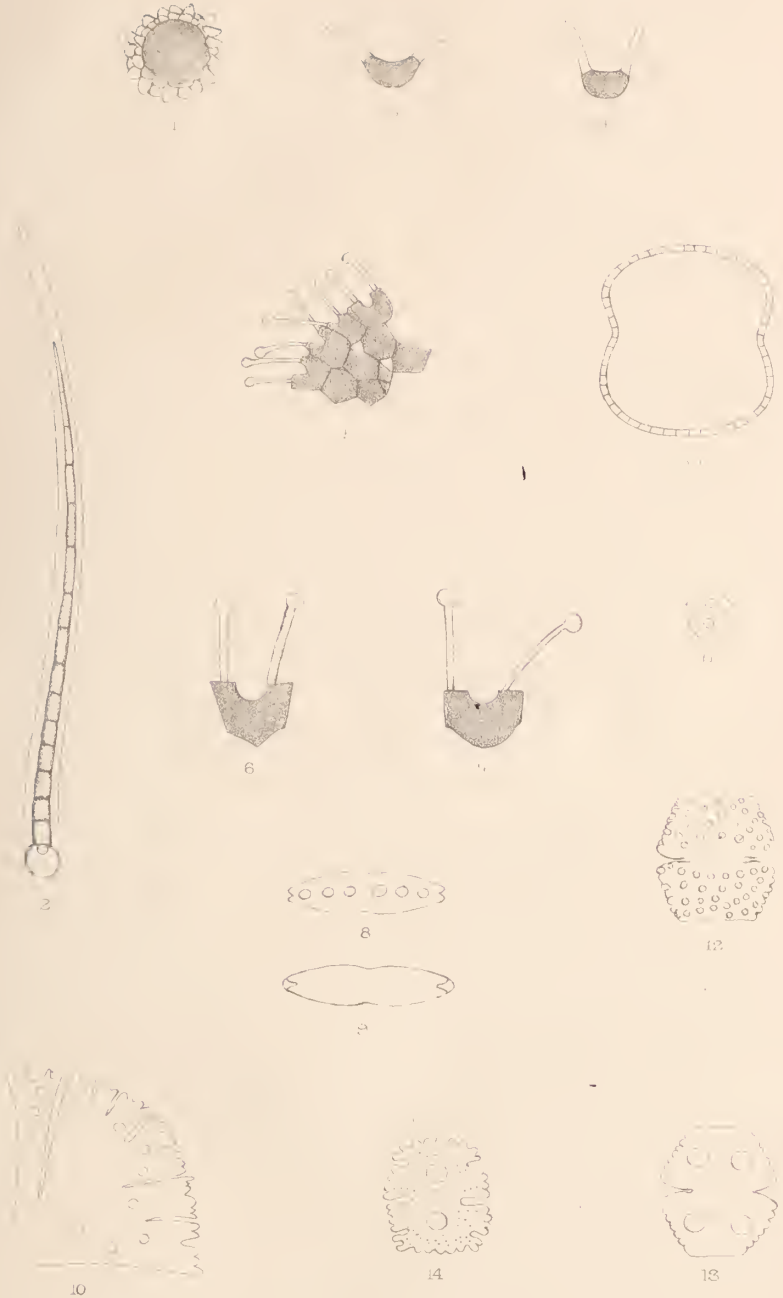
(Read 18th November, 1891.)

PLATE II.

THE district worked over in the observations recorded in this paper is a small area in Surrey, bordering on Hampshire, between Frensham to the north and Haslemere to the south, the greater part of it at a considerable elevation, rising to 900 feet at the summit of Hindhead. The geological formation of the whole of this area is the Lower Greensand, and the soil uniformly a ferruginous sandstone, a soil very unfavourable to the formation of true bog, and hence of the numerous algæ—especially desmids—which rejoice in peat-bogs. True *Sphagnum*-bogs occur in the "Devil's Punchbowl," a locality exceedingly well-known to botanists, and one of great beauty and wildness; near the "Devil's Jumps," two remarkable isolated hills to the north of the Punchbowl; on Frensham Common, and elsewhere; but they are of small extent. The two large ponds at Frensham—the larger one almost meriting to be called a lake, and also well-known to botanists—and some mill-ponds near Churt, also yielded some interesting algæ. But, on the whole, the country is a barren one both from a phanerogamic and a cryptogamic (except mycological) point of view; and the number of new species or forms observed is small. The valley of the Wey was not visited. The summer was an exceedingly rainy one; and this also is unfavourable to the collection of Freshwater Algæ, in two ways. It renders the true bogs more difficult of access. Furthermore, according to my observation, conjugation takes place, in the Zygnemacæ and Desmidiacæ, most freely when the conditions of vegetative life are unfavourable, especially when the supply of water or of moisture is limited.

EXPLANATION OF PLATE II.

- Fig. 1.—*Trochiscia pachyderma* (Reinsch) Hansg. ($\times 400$).
 " 2.—*Glæotrichia Pisum* Thur. ($\times 400$).
 " 3. } *Pediastrum gracile* A. Br.; marginal cells ($\times 500$).
 " 4. }
 " 5.— " *glanduliferum* sp. n.; portion of cœnobe ($\times 400$).
 " 6. }
 " 7. } " " " marginal cells ($\times 800$).
 " 8.—*Tetmemorus minutus* DBy., front view ($\times 400$).
 " 9.— " " " side view ($\times 400$).
 " 10.—*Micrasterias rotata* Rlf. var. *acutidentata* var. n. ($\times 200$).
 " 11.—*Cosmarium minutum* sp. n. ($\times 400$).
 " 12. }
 " 13. } " *Ungerianum* (Näg.) Arch. ($\times 200$).
 " 14.— " *Westianum* sp. n. ($\times 300$).
 " 15.—*Calocylindrus connatus* Kirchn. ($\times 200$).





The names of new species or varieties are printed in small capitals; those of species new to the British Islands in italics. An asterisk is prefixed to the names of those Desmids which, as far as I am aware, have not previously been recorded from the southern counties. Diatoms are again excluded.

PROTOCOCCACEÆ.

- Eremosphæra viridis DBy.
- Urococcus insignis Hass.
- Schizochlamys gelatinosa A. Br.
- Tetraspora gelatinosa Desv.
- Botryococcus Braunii Ktz.
- Protococcus viridis Ag.
- Chlorococcum gigas Grun.
- Scenedesmus acutus Mey.
- „ obtusus Mey.

Trochiscia pachyderma (Reinsch) Hansg. (Pl. II. fig. 1.)

The generic name *Acanthococcus* proposed by Lagerheim in 1883, was replaced by Reinsch in 1888 by *Glochiococcus*; but Hansgirg has now sunk the genus in Kützing's *Trochiscia* (Sp., p. 162). Of the species described by Reinsch (Ber. Deutsch. Bot. Gesellschaft, 1886), I have already described *T. insignis* (Reinsch) Hansg. as occurring in Hampshire, as well as a new species *T. anglica* (Benn.) Hansg. in Cumberland. I have now to record the occurrence of another species apparently identical with *T. pachyderma* (Reinsch) Hansg. It is much smaller than *T. insignis*, not more than 20–30 μ in diameter (without the prominences), quite spherical, the thick lamellose integument about $\frac{1}{4}$ the diameter of the cell, colourless, and elevated into numerous triangular prominences. It was found among water-weeds in the Great Pond, Frensham.

CHROOCOCCACEÆ.

- Chroococcus turgidus Näg.
- Aphanocapsa rivularis Rbh.
- Microcystis marginata Kirch.
- „ protogenita Rbh.
- Cœlosphærium Kützingianum Näg.
- Merismopedia glauca Näg.

Aphanothece prasina A. Br.

Forming roundish, moderately hard, olive-green masses, resembling a *Nostoc*, floating in considerable quantities on the surface of a mill-pond at Churt, near Frensham. Cells very minute, elliptical. I quite agree with Dr. Cooke in identifying this with *Palmella Mooreana* Harv.

OSCILLATORIACEÆ.

- Oscillatoria * tenerrima Ktz.
 „ limosa Ag.
 „ princeps Vauch.
 „ Frölichii Ktz.
 „ tenuis Ag.

SCYTONEMACEÆ.

- Scytonema figuratum Ag.
 Stigonema minutum Hass.

RIVULARIACEÆ.

- Glæotrichia Pisum Thur.

In the large pond at Frensham (probably the same locality as that referred to in Cooke's Freshw. Algæ, p. 279), I found several specimens of a very interesting organism which is no doubt the *Rivularia echinulata* of Engl. Bot., t. 1378 (*R. echinata* in Cooke), identified by Bornet and Flahault with *Glæotrichia Pisum* Thur. It was found only in very small quantities, in the form of radiating olive-green clusters of filaments, attached to *Anacharis* and *Utricularia*, immersed in gelatin. Each filament is inclosed in a distinct colourless sheath, often extended considerably beyond the endochrome, and very narrow at the extremity. The pseudocysts are subquadrate, about as broad as long at the base of the filament, narrowing rather rapidly in the upper part, and towards the apex several times longer than broad. At the base of each filament is a colourless spherical heterocyst, with a bright spot at its distal end. On a second visit no further specimens could be obtained.

NOSTOCACEÆ.

- Nostoc piscinale Ktz.
 „ opalinum Benn.

(*N. hyalinum* mihi, Journ. R. Micr. Soc., 1887, t. 1, f. 2, non Roem.) Precisely resembling the form previously gathered by me in Westmoreland and in Cornwall, except that the frond was quite spherical.

- Anabæna flos-aquæ Ktz.
 „ variabilis Ktz.
 „ oscillarioides Bor.
 „ „ *β elongata* (*Sphærozyga elastica* Rlfs.).
 Aphanizomenon flos-aquæ Rlfs.

* Gomont has shown (Journ. de Bot., Aug. 1891) that *Oscillatoria*, and not *Oscillaria*, is the older name.

HYDRODICTYÆÆ.

Hydrodictyon reticulatum * (L.) Lagerh.
In great abundance in a pond near Haslemere.

PEDIASTREÆ.

Staurogeneis rectangularis A. Br.
Not uncommon in the larger ponds.
Pediastrum Boryanum Men.
„ *Ehrenbergii* A. Br.

„ *gracile* A. Br. (Figs. 3, 4.)

Cœnobe small, composed of a small number of cells, not more than nine, very light green. Marginal cells deeply divided, with two long acuminate hyaline horns, which are generally curved. There has been great confusion between this species and *P. simplex* Mey. The species above described was seen several times among water-weeds in the larger ponds. I cannot doubt that it is Braun's species—which has at present been observed nowhere except in Great Britain—although the form of the marginal cells does not altogether correspond to the drawings in Cooke's Freshw. Algæ or in Ralfs's Desmidiæ (sub nom. *P. simplex*).

PEDIASTRUM GLANDULIFERUM sp. n. (Figs. 5-7.)

Cœnobe elliptical, 300-400 μ , very dark green, solid or with only very small intercellular spaces; marginal cells usually pentagonal or hexagonal, with a small semicircular incision in the external wall, two-horned; each horn springing from about mid-way between the side-wall and the incision in the external wall, quite hyaline and sharply cut off from the endochrome of the cell, very slender, capitate; marginal cells about $12.5 \times 10 \mu$; horns about 15μ long. The marginal cells somewhat resemble those of *P. Ehrenbergii*, but are not so deeply indented. The shape of the incision and the round knobs at the extremity of the horns sharply distinguish this pretty species from any other in the genus. Among water-weeds in the smaller of the two large ponds at Frensham.

VOLVOCINÆÆ.

Volvox globator L.
Eudorina elegans Ehrb.

* This was first described by Linnæus as *Conserva reticulata* (Sp. plant., 1635). When Roth established the genus *Hydrodictyon*, he altered the specific name to *utriculatum*; but the much more expressive Linnæan name must clearly be restored.

VAUCHERIEÆ.

- Vaucheria sessilis* DC.
 „ *terrestris* Lyngb.

ULOTRICHACEÆ.

- Hormiscia zonata* Aresch.
 „ *catenæformis* Rbh.

CONFERVACEÆ.

- Conferva bombycina* Lgrh.
 „ *tenerrima* Ktz.
Microspora vulgaris Rbh.
Cladophora fracta Ktz.

CHÆTOPHORACEÆ.

- Draparnaudia** *glomerata* Ag.
Stigeoclonium protensum Ktz.
 „ *tenue* Rbh.

DESMIDIACEÆ.

- Sphærozozma vertebratum* Rlfs.
Hyalotheca dissiliens Rlfs.
Docidium clavatum Ktz.
 „ *minutum* Rlfs.
Closterium didymotocum Cord.
 „ *lunula* Ehrb.
 „ *acerosum* Ehrb.
 „ *lanceolatum* Ktz.
 „ *Leibleinii* Ktz.
 „ *Dianæ* Ehrb.
 „ *Cynthia* Not.
 „ *calosporum* Wittr.

* Cooke does not record any locality for this last species from Great Britain.

- Closterium striolatum* Ehrb.
 „ *intermedium* Rlfs.
 „ *juncidum* Rlfs.
 „ *lineatum* Ehrb.
 „ *Ralfsii* Bréb.
 „ *setaceum* Ehrb.
 „ *cornu* Ehrb.
 „ *acutum* Bréb.

* This appears to be the original spelling.

Penium cylindrus Bréb.

„ *digitus* Bréb.

„ *navicula* Bréb.

A widely distributed species; probably often overlooked from its remarkable resemblance in form to a *Navicula*.

Penium closterioides Rlfs.

„ *Breissonii* Rlfs.

„ *didymocarpum* Lund.

Cylindrocystis diplospora Lund.

„ *crassa* DBy.

* *Mesotænium chlamydosporum* DBy.

Only mentioned in Cooke as occurring in Ireland.

* *Mesotænium De Greyi* † Turn.

Punchbowl; length about 80 μ .

Tetmemorus Breissonii Rlfs.

„ *granulatus* Rlfs.

„ *levis* Rlfs.

„ *penioides* Benn.

* *Tetmemorus minutus* DBy., Conj., p. 74, t. v. f. 10. (Figs. 8, 9.)

Length 45–50 μ , breadth 15–18 μ ; narrowing rather rapidly at the extremities; constriction and terminal lobing both inconspicuous; membrane quite smooth; endochrome granular, with central row of vesicles. Resembling *T. levis*, but about two-thirds its length, and broader in proportion. Punchbowl, Hindhead. Hitherto recorded from the Black Forest, Silesia, Bohemia, Finland, and the United States.

Spirotænia condensata Bréb.

„ *obscura* Rlfs.

Micrasterias denticulata Bréb.

„ *rotata* Rlfs.

„ *ROTATA* var. *ACUTIDENTATA* var. n. (Fig. 10.)

Terminal lobes of semi-cells bilobulate, with bidentate lobuli. Some of the lobuli of the lateral lobes tridentate, especially those at each extremity. Teeth of terminal lobes much sharper than in the normal form. In the Punchbowl.

Micrasterias truncata Bréb.

„ „ var. *tridentata mihl*.

„ *crenata* Bréb.

† Erroneously given in Cooke as *M. Greyi*.

Euastrum oblongum Grev.

- „ *affine* Rlfs.
- „ *didelta* Rlfs.
- „ *ansatum* Rlfs.
- „ *circulare* Hass.
- „ *sinuosum* Len.
- „ *pectinatum* Bréb.
- „ *gemmaum* Ktz.
- „ *elegans* Bréb.

**Euastrum inerme* Lund.

No British locality has yet been given for this little desmid, which seems to me sufficiently distinct from *E. elegans*. Punchbowl.

Euastrum binale Rlfs.

Cosmarium cucumis Cord.

- „ *Ralfsii* Bréb.
- „ *pachydermum* Lund.
- „ *pyramidatum* Bréb.
- „ *pseudo-pyramidatum* Lund.
- „ *pseudo-nitidulum* Nordst.

COSMARIUM MINUTUM sp. n. (Fig. 11.)

Very minute. Length and breadth about 15–18 μ ; semi-cells hexagonal; ends quite straight and parallel, each side representing a nearly equilateral triangle; incision narrow and deep; a large conspicuous pyrenoid in the middle of each semi-cell. This minute species was seen frequently in bog-pools. It agrees nearly with *C. truncatellum* (Pert.) Rbh., except in the number of pyrenoids, an important difference; also with *C. minutissimum* Heim. (Abh. Zool.-Bot. Gesell. Wien, 1891, p. 600, t. v. f. 14, non Arch.), but wants the tooth-like projections at the angles described in that species. It differs from *C. Schliephaeckianum* Grun. in the angles being sharp and not rounded; and from *C. perpusillum* West MS., from Ireland, in the sides being quite straight, and not undulate, and in its somewhat larger size.

Cosmarium Meneghinii Bréb.

This minute species was very common in bog-pools.

Cosmarium bioculatum Bréb.

- „ *tetraophthalmum* Bréb.
- „ *Brebissonii* Men.
- „ *margaritiferum* Men.
- „ *punctulatum* Bréb.
- „ *botrytis* Men.

**Cosmarium Ungerianum* (Näg.) Arch. (Figs. 12, 13.)

Medium size. Outline a nearly equilateral hexagon. Length

70–80 μ ; breadth about 75 μ ; sides 42 μ ; very nearly straight or slightly convex, with rounded base; ends 42 μ , quite straight; sinus moderately deep, triangular; membrane rough with pearly granules, which are wanting at the two extremities; two conspicuous pyrenoids in each semi-cell. Though not agreeing absolutely in measurements, I cannot doubt that this is Nägeli's *Euastrum Ungerianum* (Gatt. einz. Alg., p. 120, t. vii. A f. 10), from Switzerland, which has also been found by Lundell in Sweden. It resembles *C. botrytis*, except in its somewhat smaller size, and in the ends being quite smooth; the outline is almost exactly that of *C. homalodermum* Nordst. It was seen several times in bog-pools, Hindhead.

- **Cosmarium undulatum* Cord.
- " *conspersum* Rlfs.
- * " *sportella* Bréb.
- " *Broomei* Thw.
- " *prægrande* Lund.

COSMARIUM WESTIANUM sp. n. (Fig. 14.)

Medium size. Semi-cells subreniform. Length of frond about 52 μ ; breadth about 50 μ ; sides 17.5 μ , somewhat converging towards the apex, with about four deep crenations; apex about 25 μ long, slightly convex, with five shallow crenations; at the corners, between the sides and the apex, is a bifid projection; sinus rather wide. Membrane quite smooth, but with conspicuous punctations arranged in regular series, wanting in the isthmus. One conspicuous pyrenoid in each semi-cell. This very pretty *Cosmarium*, which was met with several times in gatherings from Hindhead, and maintains its outline with great constancy, I have the honour of naming after Mr. W. West, who has done so much in the elucidation of British desmids. Its nearest ally appears to be *C. Seelyanum* Wolle.

Cosmarium moniliforme Rlfs.

This species is remarkably constant in the character from which it derives its name, two or more individuals remaining attached after fission is complete. They continue to be enveloped in an obvious gelatinous investment.

Cosmarium globosum Buln.

- **Calocylinthus oblongus* Benn.
- " *cucurbita* DBy.
- " *Thwaitesii* Rlfs.

- * " *connatus* Kirchn. (Fig. 15.)

Though the shape differs considerably from that drawn by Cooke, I take this to be the same species. The form in the Hindhead approaches much more nearly that described and drawn by Wolle (Desm. U.S., t. xii. f. 9). Length about 120 μ ; breadth 100 μ .

**Calocylindrus* De Baryi Arch.

Xanthidium armatum Bréb.

The only species of the genus; seen in very numerous gatherings.

Arthrodesmus incus Hass.

**Staurastrum pilosum* Näg.

„ *teliferum* Rlfs.

„ *Pringsheimii* Reinsch.

„ *muticum* Bréb.

„ *alternans* Bréb.

„ *tumidum* Bréb.

* „ *aversum* Lund.

Not recorded from Great Britain in Cooke.

Staurastrum polymorphum Bréb.

„ *gracile* Rlfs.

„ *paradoxum* Mey.

„ *proboscideum* Arch.

„ *aculeatum* Men.

„ *vestitum* Rlfs.

„ *cornubiense* Benn.

Closely resembling the Cornish form, but the spines somewhat longer.

ZYGNEMACEÆ.

Zygnema pectinatum Ag.

„ *cruciatum* Vauch.

Spirogyra nitida Lk.

„ *porticalis* Vauch.

„ *longata* Vauch.

„ *insignis* Hass.

Zygogonium ericetorum, DBy., var. *terrestre*.

Covering large tracts of moss or of boggy soil in the Punchbowl with a bright claret-coloured felt, less often a dusky green. Not seen in conjugation.

MESOCARPACEÆ.

Mesocarpus pleurocarpus DBy.

Staurospermum gracillimum Hass.

SUMMARY
OF CURRENT RESEARCHES RELATING TO
ZOOLOGY AND BOTANY
(principally Invertebrata and Cryptogamia),
MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

A. VERTEBRATA:—Embryology, Histology, and General.

a. Embryology.†

Developmental Mechanics.‡—Dr. Hs. Driesch describes, under the title of “developmental-mechanical studies”—a phrase by no means above criticism—some experiments on the segmentation of the ova of *Echinus* and on the influence of light on the segmenting ova of *Echinus*, *Planorbis* and *Rana*. If one of the two first cells of the segmenting ovum of *Echinus microtuberculatus* be isolated, it segments as if it were a half of the intact embryo, but eventually forms an entire individual half the normal size. “Thus the principle of organ-forming germ-areas is contradicted, and the possibility of artificially producing twins is proved.” In regard to the second set of experiments, it seems that light has no perceptible effect on the processes of segmentation or formation of organs.

Dr. K. Fiedler§ describes some experiments on “developmental mechanics,” in which the segmented ova of Echinoids were punctured or shaken so as to isolate some of the cells. Slight injury to one of the two first cells of the segmented ovum sometimes resulted in small but normal embryos. But in most cases the result was that not even the blastula was reached. In three cases when one of the first two cells was destroyed, the remaining cell attained to a semi-blastula stage, and in two cases to what might be a semi-gastrula.

* The Society are not intended to be denoted by the editorial “we,” and they do not hold themselves responsible for the views of the authors of the papers noted, nor for any claim to novelty or otherwise made by them. The object of this part of the Journal is to present a summary of the papers as *actually published*, and to describe and illustrate Instruments, Apparatus, &c., which are either new or have not been previously described in this country.

† This section includes not only papers relating to Embryology properly so called, but also those dealing with Evolution, Development, and Reproduction, and allied subjects.

‡ Zeitschr. f. Wiss. Zool., liii. (1891) pp. 160–84 (1 pl.).

§ Sep. Abd. Festschrift zur Feier des fünfzigjährigen Doctor-Jubiläums der Herren Prof. Dr. K. W. v. Nägeli und Prof. Dr. A. v. Kölliker, Zürich, 1891, pp. 191–6.

Some Problems of Reproduction.*—Prof. M. M. Hartog discusses some questions of reproduction by the light of modern inquiries. He points out that the only absolutely agamous forms are to be found among the Monadineæ, where rest is the only agent of rejuvenescence. A frequent mode of rejuvenescence is a change in the mode of life; this is seen in apogamous and self-fertilizing organisms. In the higher Monadineæ and the Myxomycetes a plasmodium is formed, and the cytoplasm is renewed by plastogamy, while the nuclei wander from their original cytoplasts. Isogamy is the next advance, and it involves karyogamy or the reconstitution of a nucleus by the fusion of old ones. Here rejuvenescence takes the form of a new cell association. A similar rejuvenescence may take place by the mere migration of a nucleus into a vacant foreign cytoplast, as in the union of a spermatozoon with the non-nucleated fragment of the egg of an Echinoderm. Organisms that have attained the capability of karyogamic rejuvenescence may, by prolonged fissile reproduction without karyogamy, pass into a sessile condition marked by reproductive incapacity; here, therefore, karyogamic rejuvenescence has become essential to the preservation of the race.

Rapidly repeated nuclear fissions, without sufficient interval for nutrition and recovery, may lower the vital energy or constitution of the cell, and accelerate this reproductive incapacity: this may be the *physiological* import of the fissions that so frequently differentiate the gamete and determine its obligatory character. However, the reproductive incapacity of most microgametes is sufficiently explained by the extreme reduction of their cytoplasm. The incapacity due to long or repeated acts of fission uninterrupted by karyogamy is a matter of constitutional temperament or vigour characteristic only of the race, for

- (a) It is absent in primitive, agamous types.
- (b) It is slight in groups where parthenogenesis occurs, though often obsolete in closely-allied forms,
- (c) It has been lost in apogamous forms.

A further evolution of this constitutional weakness takes place in forms which are either exogamous or sexually differentiated; here the nuclei that fuse to remove this reproductive incapacity by rejuvenescence must be of distinct origin. Exogamy of isogametes cannot be taken as indicating latent sex, for it is merely the expression of karyogamic incompatibility of close blood-relations; which, under the name of allogamy, has been long since recognized when associated with and super-added to bisexuality.

The constitutional weakness reaches its highest degree in those organisms where allogamy is most marked. In all phases of plasmodial and karyogamic rejuvenescence we find the migration of the nucleus to foreign cytoplasm or the reconstitution of the cytoplasm or of the nucleus, or a combination of them, to be the sole necessary factors, and we infer, therefore, that the constitutional weakness of the later terms of a cycle of fission is largely due to the continuance of the association of nucleus and cytoplast unchanged. The author suggests that the evil effects of the prolonged association of cell and nucleus are due (a) to the nucleus responding less actively to the stimuli from the cytoplasm; (b) its consequently inadequate directive power; (c) to the resulting bad

* Quart. Journ. Mier. Sci., xxxiii. (1891) pp. 1-79.

performance of its work by the cytoplasm; (*d*) to the imperfect nutrition of the nucleus; and (*e*) to the failure of the cell as an organic whole.

Replacement theories of fertilization are inadmissible, since all fail to account for one or more of the following facts:—

- i. Multiple isogamy.
- ii. The non-discrimination of the broods of exo-isogametes into two categories, of which the members of either would pair with those of the other category, but not of their own.
- iii. The absence of "excretion phenomena" of any kind in so many cases of gametogeny.
- iv. The existence of true parthenogenesis of male as well as female gametes.
- v. The formation of a male individual from the exclusively female oosphere of the Hive-bee.

Elements of Development of Domestic Mammalia.* — Prof. R. Bonnet has published a textbook of the embryology of domestic Mammals which is reviewed by Dr. F. Maurer. The critic points out that this is the first attempt to treat of the development of the Mammalia in a thorough manner and with the use of the latest literature. In most textbooks of embryology Man is more or less made the centre of the description, and Mammals, other Vertebrates, and Invertebrates are used to fill up lacunæ. Our knowledge of the embryology of Ungulates is especially increased.

The first part of the book deals with the development of the body-form; the formation of the two primary germinal layers is explained as the division into two plates, one lying above the other, of the remains of the cleavage cell that forms the embryonic spot; the primary ectoblast (Raubert's layer) is not considered to have the value of a germinal layer, and it disappears later on. The median layer is regarded as a secondary product of the two primary layers; the author divides it into two parts—the epithelial primitive stripe with its cephalic process and an intermediate tissue which is called mesenchym: this grows between the two primary layers and functions as a supporting and packing tissue. By mesenchym Bonnet means something quite else than the Hertwigs, and the views of the latter are shown to be untenable.

The second and largest part of the book treats of the development of the organs and systems. No observations are found to support the doctrine that the nerve-fibres grow out from the neuroblasts. In the third part of the book the ovarian envelopes are described, and there is an account of the embryonic circulation and of the phenomena of birth.

Development of Seps.†—Dr. E. Giacomini has studied the development of *Seps chalcides*. This lizard is viviparous; the development of the ova takes about three months; the number of eggs which descend into the oviducts varies from 5 to 15. The ovarian ova do not exceed 2·5–3 mm. in diameter, and have not much yolk. After fertilization each lies in an incubatory chamber in the oviduct, without secondary membranes or albumen; they increase in size till they measure 21–22

* 'Grundriss der Entwicklungsgeschichte der Haussäugethiere,' von Prof. R. Bonnet, Berlin, 1891, 282 pp. and 201 figs. See Morphol. Jahrbuch, xvii. (1891) pp. 681–3.

† *Monitore Zool. Ital.*, ii. (1891) pp. 176–92, 198–209 (1 pl.).

mm. by 9-10 mm. The oviducal walls undergo modification; the incubatory chamber becomes connected with the surface of the developing embryo. All the surface of the latter is covered by the allantois and the yolk-sac, as if by two hemispherical caps; the former predominates increasingly over the latter. The serous membrane unites with both, forming an allanto-chorion and an omphalo-chorion. The allanto-chorion forms a placental union with the oviducal wall, and so—but only to a slight degree—does the omphalo-chorion. At the inferior pole of the embryo, there is formed at a certain stage a remarkable connection between the extra-embryonic ectoderm and the vitelline endoderm, but this disappears when the omphalo-chorion is formed. In the oviducts, after the birth of the young, there are slight retrogressive histological changes. The relations between the walls of the incubatory chambers and the surface of the embryo are in many ways comparable to the conditions of gestation in placental mammals.

Formation and Fate of Primitive Streak.*—Dr. A. Robinson and Mr. R. Assheton have made a series of observations on the mechanism and germinal layers of *Rana temporaria*, with the object of settling some of the much disputed questions as to the formation and fate of the primitive streak. They come to the conclusion that the blastopore is a deficiency in the posterior wall of the archenteron; that this archenteron in the Anura is not formed by invagination, but by a process of splitting among the yolk-cells, very similar to that described in the Axolotl. The situation of this archenteric cavity is first defined by the deposition of pigment in the adjacent margins of a double row of yolk-cells. No portion of the archenteric wall is formed by invaginated epiblast, for the archenteron is at first surrounded by large yolk-cells, which eventually give rise to the definite hypoblast. The ventral lip of the blastopore indicates the posterior end of the primitive ventral wall of the archenteron. There is no ventral and forward extension of the archenteron in front of and below the ventral lip of the blastopore by the production of a diverticulum in that situation. The ventral wall of the archenteron, in front of the ventral lip of the blastopore, is completed by the extension of the anterior end of the cavity, and by the withdrawal and modification of the cells of the yolk-plug.

The blastopore, or so-called anus of Rusconi, is closed by the concrescence of its lower lips; this produces a median streak characterized by the fusion of layers, along the surface of which lies a groove; this groove stretches from the ventral lip of the remainder of the blastopore as far as its original extension. The authors propose to call these structures the primitive streak and the primitive groove. Had the concrescence continued a little further, so that the whole blastopore had been obliterated by the fusion of its lips, the primitive streak would have commenced at the posterior end of the notochord, as in the chick. It seems, therefore, clear that the homologue of the primitive streak of the chick is, in the Frog, the whole of the blastoporic lip, whether fused or not.

The authors agree with Erlanger in regarding the anus of the frog as a reopening of a temporarily closed portion of the original blastopore, and not as a new perforation. They consider that the neurenteric canal,

* Quart. Journ. Micr. Sci., xxxii. (1891) pp. 451-504 (2 pls.).

which is bounded anteriorly by the dorsal lip of the blastopore, is the most anterior portion of the blastopore.

As to the fate of the streak, they report that the ventral moiety, soon after the perforation of the anus, ceases to be functional and splits up; the dorsal half, on the other hand, becomes folded on itself, like and along with the neural plate; it becomes separated from the skin and gives rise to the whole of the tail, with the exception of the greater part of the skin.

During the completion of the archenteron and before the closure of the blastopore, the mesoblast in front of the latter begins to separate from the true hypoblast along the dorso-lateral aspects of the archenteron by a process of delamination. Along the lines of attachment of the mesoblastic plates to the hypoblast, at the sides of the notochord, slight depressions may be noticed, which appear to indicate a continuation of the archenteric cavity into the mesoblast in the manner suggested by O. Hertwig. The appearances in the region of the primitive streak are such as to suggest the idea that the mesoblast is thus formed partly from the epiblast and partly from the hypoblast; but there is no definite proof of this.

The small archenteric diverticula into the mesoblast disappear after a time; they do not, it would seem, communicate with the coelom, which is formed by a splitting of the mesoblast which first occurs laterally, and then extends dorsally and ventrally as in the higher Vertebrata.

B. Histology.

Structure of Protoplasm.*—Prof. O. Bütschli gives an interesting account of the various opinions which have been or are held in regard to the structure of protoplasm. The older observers, such as Dujardin and von Mohl, regarded it as a "structureless" jelly or slime; it was called a fluid, a semi-solid, a fluid with unique properties, a fluid in a state of aggregation and so on. Brücke (1861), Cienkowski (1863), Velten, Hanstein, began to distinguish in the protoplasm a relatively stable framework from a more fluid included substance. Frommann (1864-7) and Arnold (1865-7) emphasized this reticulate or fibrillar structure of the plasma.

The most important opinions at present held in regard to the structure of protoplasm are as follows:—According to Frommann protoplasm consists of a relatively stable reticulate framework and a less dense, less refractive, less stable substance in the meshes. Many histologists of great authority accept this conclusion. According to others, such as Flemming, the darker and denser portion of the protoplasm is not a network so much as an irregular coil of fibrils. In contrast to both of the above conclusions, Berthold, Schwartz, Kölliker and others have returned to the old view of protoplasm, regarding it as a kind of emulsion, regarding reticulum and fibrils as artificial products. A fourth view is that of Altmann who regards the plasma as homogeneous jelly with very numerous vital granules imbedded in it, in fact as a zoogloea of peculiar Bacteria. To Bütschli, finally, the reticulum is but the expression of the vacuolar or foamy nature of the protoplasm.

Prof. Bütschli criticizes the various theories which regard proto-

* Sep. Abd. Verh. Deutsch. Zool. Gesell., 1891, pp. 14-20.

plasm as a reticulum, a complex of fibrils, an emulsion and a zoogloea with included granules, and advocates the claims of his own conception. After referring to his experiments with artificially produced foams, he says, "to me it seems justifiable to hope that coming generations will yet solve the riddle of protoplasm and nucleus, and finally dismiss the mystical interpretation of vital processes by referring them to physico-chemical processes."

Amitotic or Direct Nuclear Division.—Dr. H. E. Ziegler* has investigated direct nuclear division in many and various animals, and agrees with Flemming as to its import, that it does not lead to the formation of new cells, but is a symptom of more or less degeneration, sometimes, perhaps, influencing cellular metabolism by the increase of nuclear surface. Amitotic nuclear division always represents the end of a series of divisions, and is not usually followed by cell-division. The nuclei which so divide are usually large, and have been the seat of unusually intense secretory or assimilation processes. In Metazoa amitotic division is always a secondary process, and in the Protozoa it is likely that the same is true.

Herr M. Löwit† would distinguish regenerating and degenerating amitotic division. The former leads to a new formation of nucleus and cell, the latter may be associated with secretory and assimilation processes or with the approaching death of the cell.

Sig. E. Verson‡ points out that in the spermatogenesis of *Bombyx*, described by him in 1889, a giant-nucleus gives origin by indirect division to secondary nuclei which thereafter multiply abundantly by mitosis. Therefore Ziegler's conclusion is not always true.

Prof. J. Frenzel§ also believes that Ziegler has gone too far. Thus in the degeneration of the epithelial cells of the mid-gut of Arthropods the half-cell left behind after division retains, in spite of the amitotic division, the power of multiplying. He believes that direct nuclear division does not necessarily exclude true cell-multiplication.

Dr. O. vom Rath|| discusses the problem of direct division in connection with spermatogenesis. Taking the results of his study of the spermatogenesis of *Astacus* along with those of Platner and Hermann on Pulmonates, the mouse, and the salamander, he concludes that in all cases in which amitotic nuclear division occurs in the testes, it is restricted to the marginal or supporting cells. These are not directly concerned either in the proper spermatogenesis or in the processes of regeneration. The formation of the spermatozoa and the regeneration occur solely by mitosis. The marginal or supporting cells are never modified into spermatozoa. Therefore the allegation that the amitotic division of spermatogenesis is exceptional is not accurate.

Relations of the Essential Elements of the Nervous System to one another.—Prof. A. Kölliker made this the chief subject of his inaugural address to the fifth meeting of the German Anatomical Society. The chief conclusions to which he was led are:—

(1) All nerve-fibres arise from cells, and the structures which have

* Biol. Centralbl., xi. (1891) pp. 372-89.

† Tom. cit., pp. 513-16.

‡ Tom. cit., pp. 556-8.

§ Tom. cit., pp. 558-65.

|| Zool. Anzeig., xiv. (1891) pp. 331-2, 342-3, 355-63 (3 figs.).

¶ Verhandl. Anat. Gesell. (Jena), 1891, pp. 2-22.

hitherto been regarded as origins in a fibrous network are nothing more than the terminal branches of sensitive elements. The origins are either from central cells, as in the motor cerebrospinal fibres, the motor elements of the sympathetic, all centrifugal fibres of the central organs, most sensory peripheral tracts, and all centripetal fibres of the higher order, or, like the *fila olfactoria*, they arise from peripheral cells.

(2) The nerve-cells possess only partly one kind of process, and only partly two kinds of processes, nervous and protoplasmic (dendrites).

(3) The nervous processes are single—as all cells of the medulla and most of the brain, double—as the spinal ganglia of fishes, &c., or numerous, as the sympathetic ganglia, and some ganglia of Invertebrates.

(4) With regard to the course they take, nervous processes are divisible into those which, after a shorter or longer course, pass into centrifugal or centripetal fibres, and into those which break up into a number of fine terminal branches.

(5) It is possible that there are nerve-cells which have no so-called nervous processes, but only dendrites.

(6) In certain nerve-cells (higher sensory organs, part of brain, cerebellum) the dendrites appear to have nervous functions, while in others they have not. In all cases they have a nutritive significance.

(7) All processes of nerve-cells, whether protoplasmic or nervous, end freely, without forming anastomoses; consequently all passages from fibres to cells, and inversely, and from fibres to fibres, are effected by contact.

(8) Nerve-cells as much as nerve-fibres are active elements of the nervous system, and there is every reason for ascribing to them alone the higher nervous functions—sensation, motor impulses, and the psychical functions.

Some of these points require further proof.

Minute Structure of Human Spermatozoa.*—Prof. K. Bardeleben, who stated that he had an opportunity of seeing the preparations of Mr. E. M. Nelson in the company of Mr. Beck, gave an account of his own more recent studies. The head of the spermatozoon consists, in addition to the “head-cap” and “spear,” of an anterior and a posterior portion, which exhibit different reactions to colouring matters. The anterior part consists essentially of protoplasm; it is clearer than the hinder part, and generally stains feebly or not at all. The hinder parts exhibit a distinct cross-striation like muscle. A very delicate protoplasmic fringe extends from the anterior part of the head backwards to the “protoplasmic remains” on the neck and mid-piece. In the head there is an internal body,” which has already been detected by F. Miescher and by Ballowitz. It is clear, highly refractive, and either does not stain or only stains feebly; in it may be detected lines of separation, or it may be broken up into two, three, or four pieces. In rare cases phenomena of division may be observed.

The central filament of the tail and mid-piece may be followed as far as the anterior tip of the head; the latter is continued forwards into an unsymmetrically placed process which, when longest, may be twice as long as the head; it is immeasurably thin, and consists of extra-

* *Verhandl. Anat. Gesell. (Jena)*, 1891, pp. 157–64.

ordinarily finely filamentar delicate and clear protoplasm, in which about four nodal points may stain; it passes into a triangular tip which contains a slightly colourable corpuscle, and has the appearance of a recurved hook. Without staining or the use of immersion lenses only the tip and not the shaft of this "spear" is visible. At the base of the "spear" there is a corpuscle of elongated form.

The head is succeeded by a quite short, clear neck, in which a rounded corpuscle may often be seen, and this by a mid- or connecting piece. The "protoplasmic remains" which cover the neck vary in size with the age of the spermatozoon. The boundary between the mid-piece and the tail is always to be seen as a dark line. The whole of the mid-piece and of the tail, with the exception of Retzius's terminal piece, is surrounded by a protoplasmic fringe, which has a spiral course.

The form of the human spermatozoon is not always the same, and in the fresh state Prof. Bardeleben has observed five or six varieties; some are gigantic, being about 7.5μ long and 3.75μ broad.

There are various forms of movement, and the head itself may undergo changes in form. Within it there go on movements which indicate processes of division, and lead to the ejection of part from the head. In other words, polar bodies are formed just as in the ovum. This remarkable discovery explains the presence of the number of small bodies which have often been observed in sperm.

In the spermatozoa of all animals we must distinguish (1) generative matter, (2) nutrient matter (protoplasm or yolk), (3) motor protoplasm, (4) arrangements for entrance into the egg. The first of these is found in the head; the second, which is comparable to the nutrient yolk of the egg, is found in the protoplasmic remains on the neck, which become gradually absorbed in the head-cap, &c. The forward movements are effected by the tail, which can function as a fin as well as a screw. The arrangements for entrance into the egg consist of a spear, which may be produced into a recurved hook, and in the spiral fringe of the tail, which allows of boring movements.

The author is unable to decide whether spermatozoa make use of any foreign protoplasm or replace it by symbiosis with leucocytes. It is quite clear that the spermatozoon is a true cell, which differs from the ovum in its power of active movement.

γ. General.

Primitive Movements of Animals.*—Prof. J. Frenzel points out that a Flagellate, e. g. *Euglena*, may swim without moving its flagellum, or even without one, that the Heliozoa swim without any visible change in their rays and without rotation, that the same is true of the protist *Nucleariella*, and that Gregarines also move without changing their shape. So diatoms move without, Frenzel says, visible locomotor structures, and may attract small lifeless particles towards them. The same power of movement without locomotor structures is seen in some bacilli, and minute cocci are well known to exhibit a so-called "Brownian movement."

Some spermatozoa, e. g. those of the cockroach, move in definite orbits, as has been shown by Eimer and Dewitz; the spermatozoa of

* Biol. Centralbl., xi. (1891) pp. 464-74.

Cryptogams are attracted, as Pfeffer and Dewitz have shown, to certain fluids. There is certainly an attraction towards substances and towards surfaces, but the fundamental force is an attraction of masses. What is true of the heavenly bodies is true also of the minutest micrococci. In other words, Dr. Frenzel finds it necessary to assume a general attractive force in order to explain the movements of small organisms.

On the Study of the Movements of Animals.*—Herr B. Friedländer gives some good advice to naturalists and physiologists in regard to the hindering of scientific inquiry by the use of words like "will" and "instinct." His essay is a temperate protest against the use of words without knowledge, especially in "explaining" the movements of animals.

B. INVERTEBRATA.

Mollusca.

a. Cephalopoda.

Cleavage of Ovum in Cephalopods.†—Mr. S. Watase has a memoir in which he deals in an extended manner with this subject. Treating, first, generally of the animal ovum, he finds an essential fact, viz. that, however diverse the examples, they all point to the conclusion that the metazoan ovum and its derivatives, the tissue-cells, are more than a homogeneous, isotropic mass of protoplasm, devoid of definite symmetry. As van Beneden points out, the study of caryokinetic figures shows that the cell is not only uniaxial, but also bilateral. In several ova which have been carefully studied the axes of the caryokinetic figure have been seen to correspond in a definite way with the recognizable axes of a given ovum, the external shape of which is chiefly determined by the quantity and distribution of the food-yolk. The axes thus determined are maintained through the different stages of growth, and give rise to definite axes of the larval or of the adult organism.

Dealing next with the relation of the external phenomena of cleavage of the ovum to the internal phenomena or caryokinesis, he observes that (1) the interzonal portion of the caryokinetic figure consists of a bundle of filamentous substance; (2) this substance is essentially the same as the archiplasmic filaments of the spindle; (3) the length of these filaments is exactly the same as the space between the parallel bands of chromosomes in all stages; (4) the archiplasmic filaments grow in length from the poles towards the equator of the nucleus: and (5) the interzonal filaments come into existence exactly at the moment when the single equatorial "plate" divides into two parallel daughter "plates." It seems, therefore, to be probable that after the archiplasmic filaments from the two centres have reduced the chromatic contents of the nucleus into a flat "plate" by gradual lengthening, they continue to grow in the same manner, and push through between each other, just as would brushes if their ends were pushed together. Two opposing systems of the archiplasmic filaments behaving in a similar way, and lengthening in a contrary direction, would reduce the spherical nucleus first to a biconcave disc, then to a flat "plate," and, finally, into two parallel

* Biol. Centralbl., xi. (1891) pp. 417-29.

† Journal of Morphology, iv. (1891) pp. 247-302 (4 pls.).

"plates," each "plate" travelling in an opposite direction. The interzonal filaments are, according to this view, the actual continuations of the archiplasmic filaments, but, instead of consisting of a single system, as at either end of the spindle, they are composed of two systems, each dovetailing with the other and growing in contrary directions.

The author's object is to show that the origin of the spindle, its behaviour towards the nucleus, the formation of the equatorial chromatic "plate," the separation of the daughter-plates, and the formation of the interzonal filaments, are the continuation of one and the same process; that there is no reversal of activity in the middle, and no need for the introduction of several hypothetical factors.

An account is next given of the cleavage of the ovum in *Loligo Pealii*, in which particular attention is directed to the inequalities therein exhibited. The cause of unequal cleavage appears to the author to be internal, due to the peculiarities of the particular protoplasmic structure which composes the segment or segments. Differences are due, it would seem, to the slight qualitative inequalities induced by the first division. If this be so it follows that the earlier cleavage-processes are the more fundamental, and, from the morphological standpoint, more significant than those that follow them. As eggs from the same animal show similar variations in cleavage, it is possible that this tendency to vary may become hereditary.

Illex eblanæ.*—Mr. W. E. Hoyle has a note on this inadequately known Cephalopod, a specimen of which was lately taken near Plymouth. He finds that the form described by Ball as *Loligo eblanæ* is really a member of Steenstrup's genus *Illex*. After giving a revised diagnosis he describes an interesting form of hectocotylyzation. The alteration affects both arms symmetrically in their basal portion, but the right arm only is modified to the tip. About 2 cm. from the base of each arm, instead of a sucker, there is a flattened bract-like appendage, growing out from a broad base. Its distal margin is slightly notched, and has a sharp tooth at its inner extremity. On the inner margin of the arm are three conical teeth, which feel almost cartilaginous. From a comparison of four specimens of different sizes the author is led to conclude that on the hectocotylyzed arms suckers are normally developed, and gradually disappear as the animal approaches maturity.

γ. Gastropoda.

Development of *Paludina vivipara*.†—In the second part of his memoir Dr. R. v. Erlanger treats first of the development of the nervous system. Special attention is directed to the fact that all the ganglia arise quite separately from one another, and this is true even of those that are paired. The cerebral ganglia are the first to be formed, then the pedal, directly afterwards, and almost simultaneously, there appear the pallial and buccal; these are followed by the two intestinal ganglia, and last of all come the visceral. The progressive development from before backwards is also seen in the formation of the commissures and connectives. It is difficult to decide whether the pallial ganglia are in closer relation

* Journ. Mar. Biol. Ass., ii. (1891) pp. 189-92 (3 figs.).

† Morphol. Jahrbuch, xvii. (1891) pp. 636-80 (2 pls.). Zool. Anzeig., xiv. (1891) pp. 280-3.

to the cerebral or to the pedal—a matter of importance, as in the lower Prosobranchiata the pallial ganglia are in close connection with the pedal, and as the series ascends they enter into closer relations with the cerebral. In *Paludina* they lie from the first midway between the cerebral and pedal ganglia. The intestinal ganglia are in the adult very feebly developed; but it is to be noted that *Paludina* has some very primitive characters, in so far as the ganglia are very diffuse, and it is consequently very hard to say where a ganglion begins and where it ends; indeed the commissures and connectives are invested for some distance by a layer of ganglion-cells. The long pedal cords are throughout ganglionic in nature.

The sensory organs are next discussed; an otolith-vesicle is formed on either side of the foot a little before the eye, which appears at the base of the tentacle; the lens and vitreous body are certainly formed by cells of the optic vesicle. Special attention is given to Spengel's olfactory organ, the development of which can be very clearly followed in *Paludina*. It consists of an elongated ridge, rounded in cross-section, traversed for the whole of its length by a nerve which arises from the supra-intestinal ganglion; there are on it a series of pit-like depressions of the epithelium of the mantle-cavity, about twenty in number, set along the inner edge of the ridge, and partly covered by it. Spengel's organ arises as an ectodermal swelling, and is at first set obliquely to the longitudinal axis; during the course of development it alters its position until it becomes parallel to the long axis. The pits appear gradually, and are invaginations of the mantle-cavity. A nerve from the supra-intestinal ganglion soon passes into the ridge.

The vessels arise quite independently of the heart, either between the splanchnic mesoblast and the endoderm or the parietal mesoblast and the ectoderm. They soon become surrounded by a thin layer of connective tissue, and extend into the mesoderm as lacunar spaces. The first foundations of the vessels appear before there is any indication of a heart. A contractile sinus, which corresponds to a kind of embryonic heart, is formed, and, later on, becomes part of the anterior aorta; a sinus which is formed later on and lies ventrally to the liver, passes into the hinder aorta. Venous sinuses are, at a very late period, formed in a remarkable way, for the mesoderm around the intestine, which is at first compact, withdraws from it and so forms a lacunar space.

The gonads have the same kind of foundation in both sexes; the germ-gland and duct arise separately from one another. The former appears as an outgrowth of the pericardium, or, in other words, of what remains of the secondary coelom that is not filled up by connective tissue and muscles. This outgrowth becomes constricted off and sooner or later enters into connection with the primary genital duct; this duct is in itself an outgrowth from the ventral side of the ureter. Both rudiments are well seen when the larva has a distinct velum and a very well developed pair of primitive kidneys.

In the male a small part only of the seminal duct is formed from the primary genital duct—that part, namely, which extends from the testes to the angle of the vas deferens. The remainder has a secondary origin, independent of the primary duct, for it appears as a groove which extends from the floor of the mantle-cavity to the region of the head.

The groove becomes a tube and passes inwards. The gonad and the secondary duct of the male become connected with the primary duct before birth, while the gonad of the fresh-born female is not connected with the primary duct. For some time after birth the gonad of both sexes has a quite indifferent character; the efferent ducts become so far histologically differentiated that their epithelium is ciliated, while that of the gonad has no cilia. The derivation of the gonad from the pericardium is a further proof that the latter corresponds to the secondary cœlom.

Planorbis has a pericardium with a distinct septum before the heart is formed. While the renal organ is mesodermal in origin its duct is formed by an invagination of the ectoderm of the rudimentary mantle-cavity. Sections reveal the presence of an outer and an inner opening to the primitive kidney. The inner, which leads into the cœlom, is not terminal, but set laterally on the ciliated portion, at the end of which is a group of small cells indistinctly separated from one another. While that part of the primitive kidney which leads to the exterior corresponds to the large central cell, the ciliated internal part is formed of several cells, the nuclei of which are distinctly visible.

Development of *Bythinia tentaculata*.*—Dr. R. v. Erlanger has come to conclusions very different from those of Dr. P. Sarasin and in agreement with what he has already observed in the allied *Paludina*. Segmentation is of the normal Gastropod type, and most like that of *Planorbis* and *Neritina*. The hindermost macromere may be known as the endo-mesoderm-cell, for it divides into two, one of which retains the place of the hinder macromere, while the other is pushed nearer to the animal pole. This latter divides into two, but in the transverse direction; the cells thus formed are the primitive mesoderm-cells, which lie on either side of the long axis.

The germ becomes flatter and flatter, and has the form of a spherical triangle, with the apex directed forwards. The blastopore appears as a long slit which occupies the whole length of the ventral surface; the archenteron forms a pretty wide cavity; the permanent mouth is derived directly from the blastopore. There now appear the first signs of a velum in the form of a double row of clear ciliated ectodermal cells, which form a circle set obliquely to the longitudinal axis. The mesoderm has by this time become bilaminar, and forms to the right and left a sacculi; these pass into one another at the hinder end, and gradually grow out forwards and dorsalwards. The cœlom between the two layers can be easily seen.

The archenteron alters in form, becoming much narrower posteriorly. On the dorsal surface of the hinder end the shell-gland appears as a thickening of the ectoderm, and at the same time the foundations of the cerebral ganglia appear as lateral thickenings of the velar area. At this stage the glandular part of the primitive kidney appears as a clump of mesoderm-cells. At the hinder end of the blastoporal groove a small pit may be noticed, which marks the point at which the anus appears later on.

The œsophagus is formed at the point where the mouth was formed

* Zool. Anzeig., xiv. (1891) pp. 385-8.

from the blastopore, by an invagination of ectoderm; in front of the mouth are two large clear cells which belong to the velum. The velum itself is distinguished by its very large cells, which show the concretions described by Sarasin, and are ciliated.

Soon afterwards the foot is formed as an outgrowth of ectoderm behind the mouth; the œsophagus shows signs of the invagination of the radular pouch. Shell-gland, cerebral plates and mesoderm have increased in size, and a large group of cells indicates the foundation of the pericardium. The primitive kidney becomes connected with the outer world by means of an ectodermal efferent duct.

The anterior end becomes more marked off from the posterior, as the embryo increases in length; torsion begins to be noticeable; the kidney arises on the right side from a thickening of the pericardium. A little later signs of the mantle appear, and, at the same time, the rudiment of the renal efferent duct is formed.

A lumen appears in the as yet solid pericardiac rudiment, and another in the kidney; these two lumina are connected with one another by a narrow orifice, while the kidney opens into the pallial cavity, formed by the outgrowth of the edge of the mantle. The heart is formed as an invagination of the pericardium, becomes constricted in its middle, and so gives rise to an auricle and a ventricle. The ganglia arise in just the same way as in *Paludina*, that is, as separate thickenings of the ectoderm, which later on become connected with one another by commissures and connectives. The author has not seen the single ectodermal thickening lying in the median longitudinal axis, from which Sarasin derived the pedal, intestinal and visceral ganglia, and which he homologized with the ventral medulla of Annelids. At the end of this preliminary communication the author indicates the numerous points in it in which he is unable to agree with his predecessor in the study of the development of *Bythinia*.

Cryptobranchiate Dorididæ.*—Prof. R. Bergh sums up what is known of these molluscs, and endeavours to arrange the genera in more definite order. After giving a general diagnosis of the Dorididæ, he defines the cryptobranchiate forms as holohepatic Nudibranchs with median dorsal gills which consist of a number of pinnate leaflets in an arc or circle, united at their base, and almost always retractile into a cavity, with “perfoliate” rhinophoria, with a pharyngeal bulb which is never suctorial. Prof. Bergh gives a general account of the anatomy of the family, and then takes a systematic survey of the genera. Although he emphasizes that his classification must be regarded as provisional, it may be of interest to cite the sub-families:—Bathydorididæ, Hexabranchidæ, Archidorididæ, Discodorididæ, Dianlulidæ, Cadlinidæ, Kentrodorididæ, Platydorididæ, Chromodorididæ, Miamiidæ.

Reproductive System of Tectibranchiata.†—Sig. G. Mazzarelli describes the reproductive organs of *Pleurobranchæa Meckelii*, *Oscanius tuberculatus*, *O. membranaceus*, and *Acera bullata*, which have not been hitherto investigated. The peculiarities in the reproductive system of *Acera*, taken along with those of the alimentary and nervous systems,

* Zool. Jahrb., vi. (1891) pp. 103–44.

† Zool. Anzeig., xiv. (1891) pp. 233–43 (6 figs.).

seem to warrant the establishment of a new family Aceridæ distinct from the Bullidæ.

Pleurophyllidia Loveni.*—Mr. J. T. Cunningham reports that a single specimen of this rare Opisthobranch has been taken off the north of the Eddystone. Two specimens from the British area have been long known, and Mr. Holt lately took two from fishermen's haddock-lines in St. Andrews Bay.

Occurrence of Hancockia at Plymouth.†—Mr. F. W. Gamble records the discovery of a second British example of this Nudibranch; the only other specimen was taken at Tor Bay. Four specimens taken at Naples were described by Trinchese under the name *Goria*. The Plymouth specimen is apparently intermediate between *H. eudactylota* and *G. rubra*.

Reproductive Apparatus of Aplysiidæ.‡—Sig. G. F. Mazzarelli finds that all the ova which are dehiscent separately or precociously into the small hermaphrodite duct, and which mix with the seminal current, are destroyed in Swammerdam's vesicle. At different times, the semen and the ova pass along the same path—through the small hermaphrodite duct, the chamber of fertilization, the efferent duct, and the dorsal genital duct. The semen which is emitted is never pure, but mixed with ova, lecithin, and fatty corpuscles, &c. In the large hermaphrodite duct there are two distinct paths, one for the genital products, the other for the fertilizing elements. With the anterior portion of the efferent duct a gland is associated which lubricates the passage like a prostate gland. The vesicle of Swammerdam is not connected with the efferent duct, but is rather a vaginal diverticulum between the vaginal and the copulatory duct. In copulation the penis penetrates into the vaginal duct, and the semen is directed into Swammerdam's vesicle. There it is purified, and thence it passes by the copulatory duct to accumulate in the copulatory pouch. Swammerdam's vesicle is a filtering sac. The ova are fertilized in a fertilizing chamber, into which spermatozoa pass by the "duct of Cuvier"; the ova are surrounded with albumen from the albumen-gland, and are united in packets by the mucous secretion of cells lining part of the efferent duct. The packets are united in a string in the spiral portion of the efferent duct by the secretion of the nidamental gland.

The reproductive apparatus of Aplysiidæ has morphological affinities with that of Cephalopods; the large hermaphrodite duct corresponds to that of other Tectibranchiata; the fertilizing chamber corresponds to the posterior end of the hermaphrodite duct of other Tectibranchiata; the nidamental gland of Aplysiidæ is a new formation without homologue; the copulatory pouch of Aplysiidæ is not homologous with the copulatory pouch of other Tectibranchiata, it probably corresponds to the primitive nidamental gland of the Aplysiidæ. The reproductive apparatus of Aplysiidæ is more evolved than that of the Cephalaspideæ, and is more differentiated than that of Notospideæ, excepting perhaps *Umbrella* and *Tylodina*. In *Aplysia punctata*, the reproductive apparatus persists in a relatively primitive condition.

* Journ. Mar. Biol. Ass., ii. (1891) pp. 194 & 5.

† Tom. cit., pp. 193 & 4.

‡ Atti R. Accad. Sci. Napoli, iv. (1891) pp. 1-50 (4 pls.).

The Dorsal Appendages of *Tethys leporina*.*—Prof. C. Parona has observed the discharge or autotomy and their rapid regeneration of the remarkable dorsal appendages (*Phaniscurus*) of this mollusc—two facts which seem hitherto to have escaped observation.

Molluscoida.

a. Tunicata.

Embryology of Pyrosomidæ.†—Prof. W. Salensky completes his account of the intricate life-history of Pyrosomidæ, describing the formation of the tetrazoid embryo and the development of the ascidiozooids. After an outline of the changes of shape which the embryo undergoes, he gives a detailed account of the derivatives of each germinal layer.

(a) *Ectodermic*. The tunie is due in part to a great migration of mesenchyme cells into the space between the outer surface of the cyathozoid and the follicle wall, and in part to a secretion of cellulose from ectodermic cells. The nervous system of the ascidiozooid (and also of the cyathozoid) arises from an ectodermic invagination with a very small cavity. From the nervous vesicle two tubular processes grow downwards; the ciliated groove of the cyathozoid is formed from the central system; but in the ascidiozooids there are two ciliated grooves, the first due to the nervous system, that which replaces it to an evagination of the primitive gut. In the ascidiozooids there are two tentacle-like sensory structures exactly corresponding to those in *Salpa*.

The peribranchial tubes of the cyathozoid and of the first four ascidiozooids are of ectodermic origin; their development and that of the elocæ are described.

(b) *Mesodermic*. From the mesoderm arise the pericardium and the heart, the clæoblast, the problematic organs—elongated and pisiform masses—of which the former are due to the calymmoocytes, the museles of the body, and the bud-stock mesoderm which is partly of independent origin and partly a continuation of the pericardium. All these are described at length.

(c) *Endodermic*. In the later stages in the development of the germinal disc, the posterior part of the gut-cavity is distinguishable from the anterior part by the presence of the endostyle; the anterior part remains in the cyathozoid and represents the gut-cavity of the nurse-generation; the posterior part passes into the stolon as the rudiment of the gut in the ascidiozooids. The development of the two parts is described.

Salensky then explains the facts which lead him to come to the following conclusions in regard to the development of the ovary. In all Tunicates the originally homoblastic rudiment of the ovary is differentiated into follicle-cells and ova. The mono-ovular ovary of *Salpa* and *Pyrosoma* is derived ontogenetically (and surely also phylogenetically) from a poly-ovular type, and is homologous with the ovary of Ascidians. The kalymmoocytes, which appear between the ovum and its follicle, are in *Salpa* and *Pyrosoma* of extra-ovular origin, are in fact migrant follicle-cells. The homology between ova and follicle- or test-cells is proved by their origin from the same rudiment and by the modifiability

* Zool. Anzeig., xiv. (1891) pp. 293-5.

† Zool. Jahrb., v. (1891) pp. 1-98 (8 pls.).

of one type into another. So the kalymmocytes may be fairly called abortive ova. In *Salpa*, the blastomeres seem to act as centres of attraction for the kalymmocytes, regulating the disposition of the latter in the upbuilding of the body. From the facts of development, Salensky concludes that the Pyrosomidæ are derived from Synascidian types, and the Salpidæ from *Pyrosoma*-like ancestors. In *Pyrosoma*, the blastomeres and the kalymmocytes share equally in forming the embryo; in *Salpa* the kalymmocytes are the chief constructive elements. Since the embryo develops rather from the ovary than from an ovum, Salensky calls the development "œiogenesis."

In the history of the mesoderm there is alternate construction and disruption: the cœlom-sacs break up into free mesenchyme cells which are again collected. The mesoderm of the cyathozoid may be regarded as primitive, which suggests that the ancestors of Pyrosomidæ were enterocœlic.

In regard to the whole life-history, Salensky believes that the metagenesis of Salpidæ and Pyrosomidæ is incipient in Synascidians; that the nurse-generation of the metagenetic Tunicates has arisen from a precocious budding of the larval form; that in the first stages of the phylogeny the sexual generation was able to reproduce asexually (Pyrosomidæ); and that in the course of further differentiation the sexual generation lost this power of budding.

B. Bryozoa.

Budding in Paludicella and other Bryozoa.*—The following is a summary of the conclusions to which Mr. C. B. Davenport has been led by his own studies, and by the results of other investigators. All Ectoprocta build stocks or corals, the individuals in which are arranged in rows radiating from a centre, and are placed one in front of another. New rows or branches are constantly being produced peripherally, and there is no dichotomy in the branching. The body-wall and polypides of the median or ancestral branch, as well as the furculations of the lateral branches, arise from a pre-existing mass of embryonic tissue—the gemmiparous mass. This has a central position, as in the Phylactolœmata, or a peripheral, as in the Gymnolœmata.

The outer layer of the body-wall in the budding region is one of rapidly assimilating and rapidly dividing tissue; the inner layer becomes filled with food taken from the body-cavity in forms in which the latter is early cut off by a partition, but it shows no tendency to do so in those forms in which there is a cœnocœl. The first impulse to the formation of the polypide is found in the outer layer of the body-wall (except when this is highly modified, as in *Cristatella*), and many cells seem to be involved in its formation from the beginning. This outer layer is embryonic tissue derived from the tip of the stock (Gymnolœmata), or from the neck of pre-existing polypides (Phylactolœmata). It is the direct descendant of the gemmiparous tissue of the larva; the inner layer is also embryonic in the budding region, for in Phylactolœmata, at any rate, the ova arise near the neck of the polypide. The outer mural layer becomes the inner bud layer by invagination, with or

* Bull. Mus. Comp. Zool., xxii. (1891) pp. 1-114 (12 pls.).

without the formation of a cavity. The distal part of the bud, in which the alimentary tract is to arise, is formed by a rapid growth of the walls of the bud. As this rapid growth occurs earlier at the anal side than at the oral, the rectum is formed first and the stomach last. The alimentary tract and atrio-pharyngeal cavity become separated by an approximation of the lateral walls. The œsophagus arises as a pocket of the cavity, and forms a secondary union with the stomach.

The lophophore first arises in the form of two lateral thickenings of the atrio-pharyngeal wall, then as two lateral folds, the cavity of which becomes the ring-canal. Tentacles appear on the ridge of the lophophoric fold; the posterior end of the fold is the last to be formed, and, in forming, it cuts off the anal part of the atrium from the intertentacular cavity; this last, which is at first compressed, becomes circular by change in position of the oral tentacles. The ganglion arises as a depression in the floor of the intertentacular space and becomes imbedded in the pharynx, which is differentiated by the change in position of the oral tentacles. Muscles and funiculi arise from the coelomic epithelium of both the body-wall and the bud. The neck of the polypide may sink to a considerable distance below the general level of the body, and form the marginal ridge of the Phylactolœmata and the diaphragm of the Gymnolœmata. The atrial opening first arises, at a late period, by separation of the cells of the neck.

The communication plate arises in *Paludicella* as a circular fold of the layers of the body-wall, the mesodermal cells at the centre of which become cuticularized. The mesodermal cells of this form become stored with food-material before the formation of the communication plate, and yield it up to the rapidly growing bud. The regenerated, like the marginal, polypides arise in the Cheilostomata at a definite position, viz. on the wall of the operculum, from tissue left behind to give rise to the polypides, but not wholly used up in its formation. They arise wholly from the body-wall, come to lie next to the "brown body," and cause its disintegration.

The author sums up his more important theoretical conclusions in the following terms:—There is in every stock or corm of Bryozoa a mass of indifferent cell-material, which is derived directly from the indifferent cells of the larva or embryo, and which has the function of forming the organs of the different individuals, including the polypides. This mass, by constant growth and division, affords the embryonic material for lateral branches. The form of the stock and interrelation of individuals is largely controlled by food-supply.

The inner layer of the Phylactolœmatous larva represents mesoderm only; the endoderm has become vestigial through loss of the alimentary function. The polypides arise in Phylactolœmata at the pole of ingression, which is probably homologous with the aboral pole of Gymnolœmata. The inner layer of the polypide bud is composed of cells derived from the rim of the blastopore, and they are to be regarded as still indifferent, and as first becoming differentiated into ectoderm and endoderm in the formation of the young polypide. Gemmiparous tissue is a rapidly assimilating tissue possessing large nuclei, because actively assimilating, and staining deeply because full of food material.

The larvæ of the Endoprocta and Ectoprocta are to be compared by

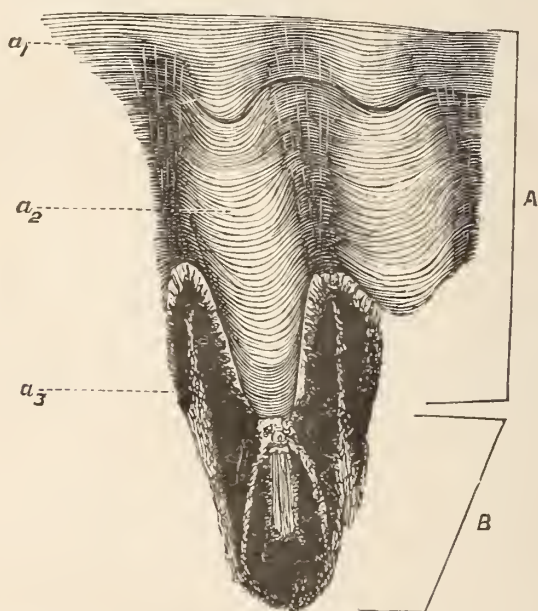
assuming that the act of rotation of the axes occurring in the former has been leapt over in the ontogeny, the mouth and anus arising at once on the pole opposite the blastopore.

Arthropoda.

Facetted Eyes of Crustacea and Insects.*—Prof. S. Exner has published a summary account of the important observations on the physiology of the facetted eyes of Crustacea and Insects, to which the attention of the Society has been from time to time directed.

For the examination of the dioptric apparatus of the facetted eye those are best adapted in which the crystalline cone is fused with the cornea; fig. 1 represents such an eye from a *Limulus*. A is the dioptric

FIG. 1.



apparatus consisting of cornea and crystalline cone, while B is the retinula. An eye of this kind can be easily removed with a fine knife and so freed of its pigment that objects may be looked at through it from behind. By the aid of the refractometer Exner found that the dioptric apparatus of a facet-segment does not consist of a homogeneous mass, but of cylindrical layers whose refractive powers decrease from the axis to the mantle. Lens-cylinders of this kind function just like lenses, but they are better adapted for the facetted eye. Thus the optic power of lens-cylinders is almost independent of the fluid surrounding them,

* 'Die Physiologie der facettierten Augen von Krebsen und Insekten,' Leipzig und Wien, 1891, large 8vo, 198 pp., 7 pls. See Biol. Centralbl., xi. (1891) pp. 581-8.

while the optic power of spherical surfaces is largely dependent on the surrounding medium.

Exner finds that a cone of the eye of a *Limulus*, from its cornea to its tip, corresponds to a dioptric apparatus which acts essentially like a lens-cylinder, and that the more the greater its focal length. As the retinula is surrounded by pigment it only receives light from a single cone, which has an optic area of about 8° . From the optic area of all the separate facets the general optic area of the eye is made up. This is an "appositionsbild" in contradistinction to a "superpositionsbild." The latter is characterized by rays of light belonging to several facets falling largely over one another. In *Lampyrus splendidula* (fig. 2) the

FIG. 2.



cornea-cylinders are separated from the retina (R) by a broad intermediate layer, and the pigment does not, as in the eye of *Limulus*, surround a single facet-segment, but one and the same part of the retina may receive light from various cornea-cylinders. This gives rise to the superposition image, which is upright.

Of the many interesting points dealt with we can only call attention to the much vexed question as to the powers of faceted eyes; at a distance of one centimetre *Lampyrus* would be able to distinguish the bar of a network not more than 0.22 mm. broad. And in others the sense of sight is even keener.

Neuroblasts in Arthropod Embryos.*—Mr. W. M. Wheeler has a preliminary notice of the results of his investigation of the development of the nervous system in *Xiphidium ensiferum*. The nervous system makes its appearance early, the ganglia arising as paired thickenings of the ectoderm in the manner so often described for Arthropods. Transverse sections through either lateral cord are seen to consist, in early stages, of two kinds of ectodermal elements; the smaller cells with rather deeply stainable elongate oval nuclei, while four larger cells have pale spherical nuclei. These four cells are the neuroblasts;

* Journal of Morphology, iv. (1891) pp. 337-43.

they lie side by side just beneath the smaller ectodermal elements; there appear to be eight longitudinal rows of these neuroblasts which extend from the mouth to the anus, and are most clearly differentiated anteriorly. The cells proliferate and each soon surmounts a pillar of smaller elements, which are the future ganglion-cells. The cytoplasm of the neuroblasts is very pale and finely granular and the nuclei are pale and refractive, while the daughter-cells stain much more deeply throughout and so resemble the elements of the tegumentary ectoderm. The "dotted substance" makes its appearance in the bases of the lateral cords, which are separated by a pyramidal mass of cells, the median cord. This mass of cells is headed by another neuroblast, which is apparently pushed below the surface by the bulging of the lateral cords. While the four lateral neuroblasts represent the cross-section of four continuous longitudinal rows of cells, the median cord neuroblasts are isolated elements which arise intersegmentally, but soon move forward between the two connectives, and finally come to lie just back of the posterior commissure in each segment. At a still later stage each is incorporated, together with the mass of cells to which it has given rise, in the posterior part of a ganglion. There is, then, a ninth unpaired and interrupted row of neuroblasts extending from mouth to anus.

The brain and optic ganglia arise as strings of cells budded off from sixteen anterior rows in the same manner as the ventral ganglia arise from the eight rows of neuroblasts. Like all the cells which they produce the neuroblasts are finally inclosed by the outer neurilemma.

The author desires to emphasize the definite number and arrangement of the neuroblasts in *Xiphidium*, because he believes the eight rows of the lateral cords to be the homologues of the two rows of cells derived from the neuro-teloblasts in Annelids. The homology of the median row is a more difficult question, which cannot yet be answered.

The development of the ganglia from neuroblasts is not peculiar to *Xiphidium* among Insects, for it is quite as distinct in other Orthoptera. The "ganglioblasts" of *Doryphora decemlineata*, previously described by Mr. Wheeler, are the same as the cells which he now calls "neuroblasts." Similar cells have been described by other investigators, but none seem to have called attention to their definite number, and to their striking similarity to Annelid neuroblasts.

From among his predecessors the author makes reference to the work of Korotneff (1885) on *Gryllotalpa*; of Graber (1889) on the large cells that give rise to the ganglionic thickenings in the dipterous *Lucilia* and the coleopterous *Liria* and *Melolontha*; Patten (1890) found that in the embryo of the Scorpion the "sense-organs" are arranged in four irregular rows in either lateral cord of the ventral chain, and there is a single median large "sense-organ"; Viallanes (1890) gives an account of the development of the brain in *Mantis religiosa*, which agrees very closely with the results obtained from a study of *Xiphidium*.

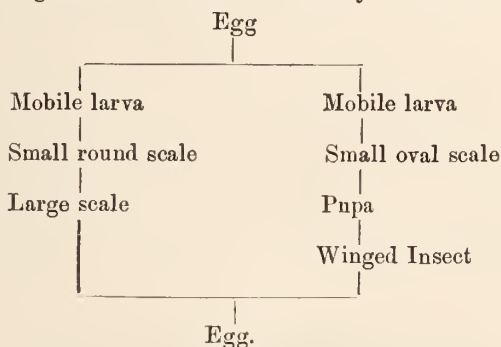
a. Insecta.

Life-History of *Aspidiotus aurantii*.*—Mr. A. E. Shipley, who undertook an inquiry into the cause of the Orange Disease in Cyprus, which is due to this scale insect, gives an account of its life-history.

* Kew Bulletin, No. 57 (1891) pp. 221-30 (1 pl.).

The various stages through which the insect passes, in the passage from the egg to the mature form, differ somewhat in the two sexes. In the female the eggs, which are found massed together under the scale, give rise to minute larvæ; these are provided with three pairs of legs and a pair of antennæ, together with well-developed mouth-appendages which form the rostrum. They move actively about in search of a convenient place of fixation. This is effected by the larva inserting its rostrum into the tissues of its host, when it sucks up the nutritive juices of the plant. Soon after fixing itself the larva casts its skin, and by so doing loses both legs and antennæ; it thus becomes fixed for life on the spot where it first took up its position. The larval skin is not entirely thrown off, but remains covering the insect, and forming the scale, shield, or puparium; the secretion from the spinnerets which serves to keep the cast skin in its place is much less than in allied species. Later on the insect undergoes a second and final moult. The skin thus thrown off is added to the first, and the insect lies as a motionless mass covered in by the two larval skins, which form the scale of the adult female. The female is probably fertilized soon after the second moult, and its body becomes swollen with eggs; these are deposited under it, and the body of the mother collapses and dries up. The early stages in the male—egg, larva, and first moult—resemble closely the similar stages in the female. But legs, wings, and antennæ are, later on, developed, and from the pupa a winged adult is produced. The posterior pair of wings are replaced by halteres, which resemble similar structures among the Diptera. The abdomen is produced into a long process or style, which forms the external organ of reproduction. During their metamorphosis the males lose their mouth-parts, and their short life is entirely devoted to fertilizing the females.

The following scheme shows the life-history of this insect:—



Honey-dew.*—Herr M. Büsgen has made an elaborate study of honey-dew. He begins with a historical account of the opinions men have held in regard to it. Pliny and many later observers said that it fell from heaven; many botanists regarded it as an exudation from the plants; many zoologists referred it altogether to the Aphides. Now it is commonly believed that there are two kinds—an animal honey-dew and

* *Jenaische Zeitschr. f. Naturwiss.*, xxv. (1891) pp. 339-428 (2 pls.).
1892.

a vegetable honey-dew. The Aphides help to make the former, how or when the latter is exuded has never been definitely stated.

But Büsgen's observations lead him to conclude that all honey-dew—excepting sugary exudations caused by parasitic fungi—is an excretion of the plant-lice. In twenty-four hours an *Aphis* can produce from 4–48 drops, so that a few plant-lice can form a large quantity of honey-dew. By experiments Büsgen has shown that the honey-dew does not induce any osmotic flow from the cells of the plants.

The author then describes the nutrition of the plant-lice, the action of their mouth-parts, the manner in which they pierce the plants, the secretion which the insects exude in the act of piercing, the whole process of sucking up the food. He then discusses the injurious effects of the honey-dew upon the plants; its presence makes it easier for fungi to establish themselves. On the other hand, the removal of sugar may be sometimes useful, as it occurs normally in nectaries, and the honey-dew attracts ants, which in moderate numbers may be also useful to plants. The results of analysing the honey-dew are noted; while intact leaves contained 4.15 parts of cane-sugar to one of inverted sugar, and no dextrin, the honey-dew contained 1.92 parts of cane-sugar to one of inverted sugar and .76 of dextrin.

The honey-dew issues from the anus of the Aphides, not from the dorsal tubes, as is often alleged. The dorsal tubes secrete a "wax-like" material which is protective, often saving the Aphides from their minute insect foes.

Relationships of Papilionidæ.*—Dr. E. Haase discusses, in a very elaborate way, the mimicry and systematic relationships of Papilionidæ. Reliable results cannot be based on a study of the markings alone; thus the genera *Doritis* and *Parnassius* are very nearly allied, but are quite different in markings. In the modification of the markings there is indeed a certain regularity, but even within a genus this does not always hold good. Among species of *Papilio*, the primitive form seems to have been yellow with about ten dark cross-bands on each wing. In *Sericanus* and *Armandia*, two genera nearly related to *Papilio* as regards venation, simple modifications of the primary marking occur in the fusion of adjacent bands and intervening zones. The cross striping on the upper surface of the wings of *Doritis* is also primitive, and leads on to spots and bands. In our limited space it is not possible for us to do more than notice the general tenour of this memoir, especially since the comparison of different forms involves an exceedingly complex nomenclature.

B. Myriopoda.

Reproduction of Diplopoda.†—Dr. O. vom Rath points out that the rarity of embryological researches on Myriopods is in part due to ignorance in regard to their reproduction. He has therefore studied this in the Diplopoda, especially in the genera *Polydesmus*, *Julus* and *Glomeris*. In Diplopoda the reproductive organs lie under the gut, and

* Bibliotheca Zoologica (Leuckart and Chun), viii. (1891) pp. 1–112, 9 figs (xi. (?) pls. not yet published).

† B.-r. Nat. Gesell. Freiburg i. B., v. (1890) pp. 1–28 (1 pl.).

their ducts open between the second and third pairs of legs. In Polydesmidæ, Julidæ, and Glomeridæ, the paired ovaries are inclosed in one sheath; they extend to the second last segment; anteriorly each efferent duct ends in a sac-shaped vulva. The testes are very like the ovaries; in Polydesmidæ and Julidæ they are connected by transverse bridges, in Glomeridæ the union is more complete. In Julidæ each of the vasa deferentia is provided with a penis, but all male Diplopoda (except Polyxenidæ) copulate by means of modified appendages—on the seventh segment in Polydesmidæ and Julidæ, on the second last segment in front of the anus in Glomeridæ. The spermatozoa of *Polydesmus*, *Julus* and *Glomeris* are round cells, not tailed as in Chilopoda. Egg-laying occurs 25–30 days after copulation; the eggs are fertilized as they are laid. In Polydesmidæ and Glomeridæ the larva which leaves the egg has three perfectly developed pairs of limbs and rudiments of others; in Julidæ the hatched embryo is without free appendages, and undergoes moulting before these appear. In Polyxenidæ the newly hatched larva has only three well-developed pairs of limbs. After a general survey the author proceeds to discuss each family in detail.

Life of Millipedes.*—Dr. O. vom Rath gives an interesting account of the general life of Diplopoda, discussing what the Germans call their Biology. He describes some common forms, *Polyxenus lagurus* which alone represents the family Polyxenidæ, *Atractosoma*, *Craspedosoma*, and *Chordeuma* among Chordeumidæ, and adds to his previous investigations further details about the reproductive organs and copulation of these forms. In regard to the nest of earth which Polydesmidæ and Julidæ form around their eggs, vom Rath believes that they simply utilize the nearest available material and cement it with a secretion probably from the anal region. The larvæ pass through definite stages marked by the number of segments and appendages. There are six of these stages in the life-history of *Glomeris*, eight in *Polyxenus*, and sexual maturity in Polydesmidæ, Julidæ, and Glomeridæ is not reached in the first year.

All Diplopoda except Polyxenidæ have a chitinous cuticle with abundant carbonate of lime; *Polyxenus* is protected by its penial hairs; the Glomeridæ roll themselves up in a ball, the Julidæ, Polydesmidæ, and Chordeumidæ in a spiral; the Glomeridæ are most sluggish, next come the Polydesmidæ, while the Polyxenidæ and Julidæ are much more active, being able to move, for instance, up the vertical glass sides or along the glass roof of their prison. Most are protected by their lurking habits and by their foramina repugnatoria or protective glands which give the animals a disagreeable smell and taste. In Polyxenidæ and Chordeumidæ true foramina repugnatoria are absent, but cells at the base of the hairs and bristles have a glandular appearance. By experiments vom Rath has shown how repugnant the Diplopoda are to hungry birds and spiders. The mid-gut is abundantly infested with Gregarines; young Nematodes are also frequent endoparasites; and parasitic fungi cause much mortality. The Diplopoda are readily killed by drought and heat, while in winter they bury themselves, and are little affected by the cold. Corroborating Plateau's experiment, vom Rath has shown that Julidæ and Glomeridæ can survive prolonged

* Ber. Nat. Gesell. Freiburg i. B., v. (1891) pp. 161–99.

immersion in water. Finally, the author discusses the numerous colour-variations, and finds that they are protective adaptations to the colour of the environment, and established, he believes, by natural selection.

New Mode of Respiration in Myriopoda.*—Mr. F. G. Sinclair (formerly F. G. Heathcote) describes a special organ in the Scutigerridæ. Each consists of a slit bounded by four curved ridges and leading into an air-sac. From this sac a number of tubes are given off, which are arranged in two semicircular masses. The ends of the tubes project into the pericardium in such a manner that the ends are bathed in blood and aerate it, just before it is returned into the heart by means of the ostia. In the living animal the blood can be seen through the transparent chitin of the dorsal surface surrounding the ends of the tubes. The tubes each branch several times, and each tube is lined with chitin, which is a continuation of the chitin of the exo-skeleton. Each tube is also clothed with cells which are a continuation of the hypodermis. The tubes end in a blunt point of very delicate chitin. These organs are supposed to be respiratory since there are no other organs that can be supposed to have that function; the chitinous lining grows thin and membranous towards the end, and so affords a good opportunity for interchange of gases; the ends are bathed with blood; the tubes are filled with air, and the organ is so placed as to aerate the blood just before it returns to the heart. It is probable that these organs are a recent modification, for they are arranged on the dorsal scales, or, in other words, are not arranged in correspondence with the mesoblastic or primitive segmentation.

This mode of respiration differs from that of other Myriopods in the following points—the tubes are collected into one definite organ, instead of being distributed about the body; they have no spiral thread; in acting on the blood just before it returns to the heart.

After pointing out the resemblances to the tracheæ of other Myriopods and the resemblances to and differences from the tracheal lungs of Spiders, the author suggests that the respiratory organ in *Scutigera* holds a position intermediate between the tracheæ of Myriopods and the lungs of Spiders. He agrees with Leuckart in thinking that the tracheæ have developed into the lungs of Spiders and Scorpions; the respiratory organs of these forms make a series, the lowest term in which are the tracheæ, then the organ of *Scutigera*, then the lungs of Spiders, and lastly those of Scorpions.

Anatomy of Chilopoda.†—Dr. C. Herbst first describes the various glands—the head-glands of *Scutigera*, *Lithobius*, *Henicops*, and *Scolopendra*, the poison-glands, the glands of the terminal segment, the coxal, anal, and pleural glands. On the head two different types occur. In some the sacs or tubules empty their secretion directly to the exterior, as in *Scutigera*, and in two sets found on *Lithobiidæ*. In others there are long efferent ducts, which are either terminally expanded in a complex lobed mass, as in one of the sets occurring on *Lithobius* and *Henicops*, and four of the sets on *Scolopendra*, or end simply in little glandular sacs, as

* Proc. Roy. Soc. Lond., l. (1891) pp. 200-1.

† Bibliotheca Zool. (Leuckart and Chun), ix. (1891) 42 pp. (5 pls.).

in the fifth set occurring on *Scolopendra*. As to the homologies of these glands with one another, or with those of insects, the author is too cautious to come to any conclusions until developmental data are forthcoming. A chapter is devoted to the coxal organ of *Scutigera*—a structure by itself—which perhaps favours the rupture of the limbs.

After a detailed account of the vascular system in various types of Chilopoda, Herbst gives the following general sketch. In the mid-dorsal line lies the heart, surrounded by annular muscles and generally inclosed in a distinct cavity, on the walls of which the alary muscles are inserted. In each segment the heart gives off a pair of lateral branches, which ramify, and, in *Scolopendra* at least, give rise to a rich plexus in the peritoneum. Anteriorly the heart always passes into the cephalic aorta, also with lateral branches; posteriorly the arrangements are diverse. From the pericardial cavity the blood passes into the heart by ostia of diverse structure. In all forms examined, a nerve-strand was detected on the mid dorsal line of the heart. In the segment with the poison-claws, the dorsal vessel gives off a pair of large lateral branches, which open ventrally in a supra-neural vessel extending posteriorly above the nerve-cord and giving off at each ganglion lateral branches, which enter the corresponding pair of limbs. From the arteries of the limbs the coxal or pleural glands are supplied. In the last chapter of his memoir, Herbst describes the visceral nervous system, of which almost nothing has hitherto been known. That of *Scutigera* strikingly resembles that of *Peripatus*, and may be taken as primitive. When the head is compressed, as in *Scolopendra*, there is no distinct frontal ganglion, as there is in Scutigeridæ in which the head is high and roomy.

γ. Prototracheata.

Oviparity of *Peripatus Leuckarti*.*—Dr. A. Dendy brings forward evidence to show that this species of *Peripatus* is oviparous. He describes the deposited egg as being very large, oval in shape, with a very tough thick membrane, inclosing a quantity of thick milky fluid full of yolk-granules. The outer membrane is exquisitely sculptured and embossed in a regular design, consisting of little crumpled papillæ, with much finer meandering ridges occupying the spaces between them. The eggs appear to be laid in or about July, and the young are hatched at the end of October. As eggs have been found in specimens killed in December it is possible that this species is double-brooded.

δ. Arachnida.

Development of *Scorpio fulvipes*.†—Mr. M. Laurie has investigated the development of this Arachnid, the history of which differs considerably from that of *Euscorpius*. The difference is due to the absence of yolk in *Scorpio*. In consequence of this everything is sacrificed to the rapid development of the organs necessary for nutrition—chelicerae, stomodæum and gut—while the other appendages and the mesoblast and nervous system are formed at leisure after nutrition has been provided for. The developmental period extends over more than six months.

* Proc. Roy. Soc. Victoria, 1891, pp. 31-4.

† Quart. Journ. Micr. Sci., xxxii. (1891) pp. 587-97 (1 pl.).

The first organ to appear is the stomodæum, which has the form of a tube, the walls of which are at first one cell thick; the position of the gut, before its formation, is shown by a large cylindrical mass of yolk, the central portion of which has a curious honeycombed appearance. While in *Euscorpius* the chelicerae do not appear till after five other pairs, in *Scorpio* they are the first to be seen; in their earliest stages they are represented by a pair of solid outgrowths on the ventral surface. During the later stages of embryonic life the embryo nourishes itself by the destruction of a cord of cells which form a coiled appendix to the stomodæum; this cord is held in position by the chelicerae, so that we see the reason for the early appearance of those organs.

Lateral Eyes of Spiders.*—Mr. K. Kishinouye states that he failed in his first study † of the development of the eyes of Spiders, to notice a very important stage. All their lateral eyes arise from a common thickening of the hypodermis on each side at the posterior, external corner of the lateral vesicle.

This thickening is slightly invaginated and consists of cells arranged in many, irregular rows. Later on, the invagination disappears, and the hypodermic thickening is now flat above the lateral vesicle, which is at this time separated from the general ectoderm.

A little later differentiation occurs at three places in the hypodermic thickening; nuclei become a little larger and stain slightly less than those found elsewhere. These three groups form the retinal portion of the three lateral eyes; they receive their nerves from a portion of the brain formed by the lateral vesicle. The latter, therefore, is the optic ganglion, formed from an invagination independently of the semicircular cephalic groove which gives rise to the brain proper. The common hypodermic thickening of the lateral eyes of Spiders is most probably homologous to the hypodermic thickening of the lateral compound eye of *Limulus*, as the position is the same in both, and in both an invagination is similarly produced. The author is inclined to believe that the lateral eyes of Spiders are separated, enlarged and modified ommatidia of a compound eye of their ancestor. The history of development in the Scorpion would appear to be the same to judge from the account given by Parker; while Lankester and Bourne arrived at this same conclusion, but stood in need of the embryological proof.

Another point which the author claims as in his favour is that the number and the relative position of the simple eyes of Spiders and Scorpions vary very much. This separation and modification of the ommatidia of a compound eye into simple eyes are probably the effects of a change in the animal's habits—it ceases to wander about in pursuit of prey and lies in wait for it instead!

e. Crustacea.

Sensory Hairs of Crustacea.‡—Prof. C. Claus calls attention to various passages in his numerous papers which describe the sensory hairs of Crustacea. The entrance and termination of the nerve in the hair, the difference between the axial part which consists of processes

* Zool. Anzeig., xiv. (1891) pp. 381-3.

† See this Journal, 1891, p. 463.

‡ Zool. Anzeig., xiv. (1891) pp. 363-8.

from nerve-cells and the peripheral strands of striated substance due to the matrix cells, the distinction between sensory hairs and ordinary bristles, have all been described by Claus, though subsequent investigators do not seem to have been always aware of this.

Development of *Palinurus vulgaris*.*—Although several naturalists have worked at the development of the Sea Crayfish Mr. J. T. Cunningham has not been able to find any correct figure of the larva, or any account of the larval stages. Till July 1891, none but solitary specimens of Phyllosomes had been taken at Plymouth, because the right kind of net had not been used; with a large net made of mosquito-netting and used at the surface Mr. Cunningham succeeded in taking a large number of these larval forms. He gives a detailed description of the newly hatched larva of *Palinurus*, the largest and most developed of those which he obtained being 7 mm. long; Claus, however, obtained some stages at Messina which appear to be stages of the young of this species, and the largest of these was more than 21 mm. long; the smallest *Palinurus*, which had all the characters of the adult, observed by Richters was 25 mm. long, so a small gap now only remains to be filled up.

Distribution of Copepoda.†—Dr. W. Giesbreeht continues his account of the geographical distribution of the Copepoda collected on the 'Vettor Pisani' expedition.

Vermes.

a. Annelida.

Work done by Lobworms.‡—Mr. C. Davison, in imitation of Mr. Darwin's well-known investigations into the work done by earthworms, took the opportunity of a short stay in Holy Island, to study the work performed by lobworms on the surface of tidal sands. The average number of castings was found to be 82,423 per acre, or more than 50,000,000 per square mile. Castings were collected and weighed, when the average of four estimates showed that the amount of sand brought up to the surface by lobworms every year is 1911 tons per acre, or the weight of sand brought up by lobworms is 136 times the weight of soil brought up by earthworms over an equal area in the same time. The estimate is certainly below rather than above the actual quantity which is brought up. The average thickness of the sand is 13 inches.

New Genus of African Earthworms.§—Mr. F. E. Beddard gives a detailed account of an interesting earthworm from Lagos, West Africa, which he calls *Libyodrilus violaceus*, and takes the opportunity of reporting some observations on the post-embryonic development of certain organs. Attention has already been called to the unique disposition of the nephridia; other characters are the possession of a large unpaired sac, which opens on segment xiii., extends through five segments, and lodges receptacula ovorum; there are two atria, with thick muscular walls, which open by a common median orifice; each is furnished with

* Journ. Mar. Biol. Ass., ii. (1891) pp. 141-50 (2 pls.).

† Atti R. Accad. Lincei—Rend., vii. (1891) pp. 276-82.

‡ Geol. Mag., viii. (1891) pp. 489-93.

§ Quart. Journ. Micr. Sci., xxxii. (1891) pp. 539-86 (2 pls.).

a single penial seta. There are no calciferous glands or ventral pouches to the œsophagus.

In a young worm, just escaped from the cocoon, there is no integumentary nephridial network; in the young, again, the reproductive organs resemble those of other earthworms, but in the adult there is the large unpaired sac already mentioned; this is developed from mesoblastic tissues, and is not, therefore, the morphological equivalent of the spermathecae in *Lumbricus*, though it performs the same functions; the sac, which is at first in open communication with the cœlom, is formed internally and then grows out towards the epidermis; the ovaries which are inclosed by it disappear before the sac is completed.

The testes and vas deferens occupy the typical position and exhibit the typical structure, as do also the two pairs of sperm-sacs. The sperm-ducts are not, as in other Eudrilids, dilated to form sperm-reservoirs, but open into the tubular atria. There are three gizzards, and in the early part of the intestine there are three typhlosolar folds; later on the median of these alone persists. The area which surrounds the setæ of each side of the body is shut off from the general body-cavity, and a paired series of chambers is thus formed; in the œsophageal region a perihæmal cœlomic space surrounds the subœsophageal vessels.

Encystment of *Æolosoma*.*—Mr. F. E. Beddard has made some observations on a British species of *Æolosoma*, which seem to show that this fresh-water Oligochaete undergoes encystation in autumn, when asexual reproduction ceases. The cysts are small enough to travel easily and thus effect the wide distribution of the species.

B. Nemathelminthes.

***Ascaris lumbricoides* found in peritoneal sac.†**—W. Bergmann describes a case in which the macerated body of an *Ascaris* was found close to the vermiform appendix of a patient who had died of peritonitis after perforation of the appendix by a coprolite or fæcal calculoid. Apparently the presence of the worm was an accidental occurrence after the perforation.

γ. Platyhelminthes.

***Othelosoma Symondsii*.‡**—The form described under this name, in 1869, by the late Dr. Gray, who regarded it as a Gastropod, was re-examined by Prof. L. Graff on his recent visit to this country, at the British Museum. He concludes that it is a Land Planarian, allied to, if not belonging to the genus *Rhynchodemus*.

***Haplodiscus piger*.§**—Prof. L. Graff comes to the conclusion that the form described under this name by Prof. Weldon, and regarded by him as a sexually mature Cestode or Trematode larva, is an acœlous Turbellarian, and belongs to the genus *Convoluta*. Had a specimen been examined entire instead of by sections only this would have been at once apparent.

Ciliated Pits in Australian Land Planarians.||—Dr. A. Dendy reports the discovery, in every Australian Land Planarian examined, of

* Ann. and Mag. Nat. Hist., ix. (1892) pp. 12-19 (2 figs.).

† Prager Med. Wochenschr., 1890, No. 50. See Centralbl. f. Bakteriöl. u. Parasitenk., x. (1891) p. 259.

‡ Zool. Anzeig., xv. (1892) pp. 7-9. § Zool. Anzeig., xv. (1892) pp. 6 and 7.

|| Proc. Roy. Soc. Victoria, 1891, pp. 39-46 (1 pl.).

ciliated pits at the anterior end of the body; these are placed just inside the line of eyes, where they formed a single row of, in some cases, as many as thirty on either side. These pits may measure not more than 0·017 mm. in outside transverse diameter. Under a high power the pits are seen to have a very characteristic sharp double outline, the thick wall of the pit being composed of almost cubical cells arranged in a circle. The cilia in the pits work in a spiral or vortex. Occasionally the wall of the pit is seen to contract suddenly and spasmodically, but this happens rarely and with no regularity. The pits appear to be supplied with special nerves from the cerebral ganglion. It can hardly be doubted that they are sense-organs, and Dr. Dendy thinks their special function is olfactory. As suggested by Moseley, it is not unlikely that they are homologous with the cephalic pits of Nemertines.

New Land Planarians.*—Dr. A. Dendy describes some Land Planarians which have been found since his recent memoir on them was printed. One of the most interesting of them was *Rhynchodemus simulans*, as, with the exception of a single specimen found not far from the New South Wales border, it is the first time the genus has been found in Victoria.

Parasitic Trematoda.†—Dr. M. Braun has a report on recent advances in our knowledge of animal parasites. E. Selti‡ has investigated the forms of ova; the Monogenea are generally characterized by the spindle form, and the Digenea by the ellipsoidal. The ova of the Tristomida diverge most from the type, as they are three- or four-cornered, and by the production or atrophy of one or all the corners may take on very various forms, and there is even individual variation. G. St. Remy§ has published a synopsis of the monogenetic Trematodes, in which keys are given for the various groups and for genera; this will probably be very useful to all who are engaged in the study of these forms. P. Sonsino|| describes, under the name of *Anoplodiscus*, a Trematode from the gills of *Pagrus orphus*, which stands between the Tristomida and the Gyrodactylida. E. Lönnberg¶ gives an account of a specimen of *Distomum goliath* van Ben. from *Balænoptera rostrata*.

New Trematode found in Cattle.**—Mr. A. Hassall describes a new fluke, which he proposed to call *Fasciola carnosa*, but now names *F. americana*, which is found in the liver and lungs of American cattle. It is intermediate in size between *F. hepatica* and *F. gigantea*, being 45 mm. long and 22 broad. The intestine is much more branched than that of the common fluke.

Cestoda.††—In reporting on recent papers on Cestoda Dr. M. Braun speaks, among others, of J. C. Huber's 'Bibliographie der klinischen Helminthologie.' Sonsino‡‡ reports three cases of *Tænia nana* from Pisa,

* Proc. Roy. Soc. Victoria, 1891, pp. 35-8.

† Biol. Centralbl., x. (1891) pp. 421-7. ‡ Atti Soc. Ligust., ii. (1891) 7 pp.

§ Rev. Biol. du Nord, iii. (1891) pp. 405 *et seq.* (1 pl.).

|| Proc.-verb. Soc. Tosc., 1890.

¶ Verh. Biol. Ver. Stockholm, iii. (1891) 14 pp. (1 pl.).

** Centralbl. f. Bakt. u. Parasitenk., x. (1891) pp. 464 & 5; Amer. Vet. Rev., 1891, pp. 208 & 9 (1 fig.).

†† Biol. Centralbl., x. (1891) pp. 427-30, 465-71.

‡‡ Rev. Gen. Ital. Clin. Medica, iii. (1891) Nos. 8 and 9.

and cases have also been observed by Wernicke* and R. Blanchard.† Among the numerous contributions of the latter is one‡ on the Helminths of Anthropoid Apes; the Chimpanzee and the Orang are infested by closely allied species of *Bertia*; this genus appears to be confined to Anthropoids. Railliet§ has observed that *Cœnurus serialis* may live in French rabbits for more than two years. The question of the bifurcation of Cestodes is discussed by R. Moniez.||

Tailed Cysticercoids.¶—Dr. O. Hamann describes two new tailed cysticercoids from *Gammarus pulex*. It is likely that the adult forms which he calls *Tænia bifurca* sp. n. and *Tænia integra* sp. n. are parasitic in birds. The most interesting fact about these cysticercoids is their likeness to cercariæ. In a postscript Hamann refers to Mrázek's discovery of a similar cysticercus (*C. Hamanni*) in *Gammarus*, and to the fact that the cysticercoids of *T. sinuosa* and *T. tenuirostris* (discovered by Hamann in *Gammarus*) occur also in various species of *Cyclops*, and vary slightly according to their hosts.

Solenophorus and Duthiersia.**—Drs. F. S. Monticelli and C. Crety seek to show by a detailed comparison of these tapeworms—characteristic respectively of Boidæ and Varanidæ—that they represent two genera distinct from one another. They are to be ranked in a subfamily Solenophorinæ, beside Bothriocephalidæ, Lingulidæ, &c., in the family Dibothria. They give a critical account of *Solenophorus megacephalus* Creplin and *Duthiersia fimbriata* Diesing.

Tænia inermis fenestrata.††—Dr. A. Maggiora obtained from a patient a specimen of the somewhat rare form of tapeworm known as *Tænia fenestrata* and this he was able to identify as being an anomalous form of *Tænia mediocanellata*, a species very liable to malformations. The length of worm obtained was 68 cm., and the number of segments 52. The genital openings were lateral and alternate; the uterus had on each side about 20 branches with dichotomous subdivisions; the mature eggs were oval and corresponded in size to those of *mediocanellata*. The identification rested with about 20 normal segments, the remainder showing the malformations characteristic of *Tænia fenestrata*. The changes began as small pits and these towards the more mature end of the worm became larger and larger both in breadth and depth until the last 15 segments were reduced to a mere edge, thus causing them to resemble a ladder.

Examination by means of a lens of segments apparently normal, showed the presence of numerous white spots and projections—a fact already noted by Danysz. The author not only corroborates Danysz's observation, but accepts his view about their being the cause of the perforations. The spots are, according to this view, degeneration foci

* Anal. Circul. Med. Argentino, xiii. (1890) p. 349.

† CR. Soc. Biol. Paris, iii. (1891) pp. 441-3.

‡ Mem. Soc. Zool. France, 1891, pp. 186-96 (3 figs.).

§ Bull. Soc. Zool. France, xvi. (1891) pp. 157-60.

|| Rev. Biol. du Nord, iii. (1891) pp. 157-8.

¶ Jenaische Zeitschr. f. Naturwiss., xxv. (1891) pp. 553-64 (1 pl.).

** Mem. R. Accad. Torino, xli. (1891) pp. 381-402 (1 pl.).

†† Centralbl. f. Bakteriöl. u. Parasitenk., x. (1891) pp. 145-51.

which cause the destruction of the superjacent cuticula and thus expose the segments to the action of the intestinal juice.

5. Incertæ Sedis.

Salinella.*—Prof. J. Frenzel has applied the name of *Salinella* to the remarkable multicellular Infusorium-like animal of which he has already published a short description.† He points out the differences between Protozoa and Metazoa, and suggests that *Salinella* is a Mesozoon, or intermediate form between unicellular and multicellular animals. He regards it as a mid-gut animal, for its enteric epithelium is formed of typical mid-gut cells. He was able to observe the endogenous formation of new cells in some of the larval cells, but was unable to carry his observations further.

Echinodermata.

Morphology of Echinodermata.‡—M. L. Cuénot, in his full paper, the abstract of which we have already noticed,§ makes some suggestions as to the ancestry and classification of the Echinodermata.

The common ancestor of the Synaptidæ would be *Prosynapta* (almost identical with the *Pentactæa* of Semon); it had a globular or elongated body with calcareous spicules; a straight digestive tube with the blastopore or anus; a superficial nervous system formed by five thickened ectodermal bands uniting in an oral ring, continuous with the endodermic wall of the œsophagus; an ambulacral apparatus formed by an oral ring and giving off five interradial tentacles and an aquiferous tube opening to the exterior by a single pore, with probably a Polian vesicle. It had five radial schizocœlic sinuses, but no lacunar apparatus. Gonads forming a group as in adult Synaptæ.

The common ancestor of the Holothurians (in his amended sense, that is, without the Synaptidæ) would be *Proholothuria*. It would have had a globular or elongated body with disconnected calcareous plates; a straight or spiral digestive tube with the blastopore as anus. Nervous system as in *Prosynapta*. Ambulacral apparatus formed by an oral ring giving off five radial branches provided with ambulacral feet; water tube as in *Prosynapta*; the five radial ambulacral canals terminated by tentacles ranged in a circle around the blastopore. The rest as before.

The common ancestor of the Pelmatozoa would be *Procystus*. It would have had a globular body but no stalk, the integument incrustated with calcareous plates (a dorso-central and several superposed rows arranged in alternate series, and in pentameral symmetry). The digestive tube would have had the form of a globular sac without an anal orifice; the nervous system superficial; ambulacral apparatus formed by an oral ring, giving off five radial branches with feet, a single water-tube. Five radial schizocœlic sinuses and gonads on the Holothurian type.

The common ancestor of the Echinoids may be called *Proechinus*; the globular body would have been entirely invested by calcareous plates, forming a definite series at the apical pole of a dorso-central, five interradial basal and five radial terminals. Digestive tube without an anus; superficial nervous system; the ambulacra would terminate by an

* Biol. Centralbl., xi. (1891) pp. 577-81. † See this Journal, 1891, p. 602.

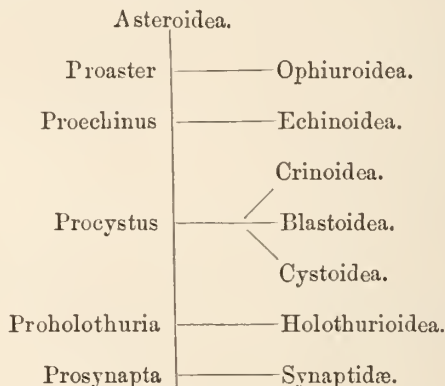
‡ Archives de Biol., xi. (1891) pp. 313-680 (4 pls.).

§ See this Journal, 1891, p. 746.

unpaired tentacle, in contact with the terminal plate; water-tube opening by a single pore, and probably without any relation to a calcareous plate. Five radial schizocœlic sinuses and perhaps an oral schizocœlic ring; no masticating or lacunar apparatus.

The axial enterocœl, which is rudimentary in *Prosynapta*, *Proholothuria* and *Procystus*, would be well developed, and have in its interior a lymphatic gland. The gonads would take a radial form.

It is suggested to give the name of *Proaster* to the common ancestor of Asteroidea and Ophiuroidea. The author imagines it to have had a pentagonal form of body, and to have been invested by calcareous plates; at the apical pole a dorso-central, a ring of basals, and a ring of terminals; between these two last would appear a new series, the radials. Digestive tube aprocous, and in the form of a globular sac; nervous system superficial. Ambulacral apparatus identical with that of Echinoids. The system of five radial schizocœlic sinuses, opening into an oral ring, would have communicated with the celom on the one hand and the enterocœl on the other; the latter would be well developed and inclose the ovoid gland which gives rise to the genital organs. The gonads radial.



The author gives the accompanying table to illustrate his views, and urges as their recommendation that the ancestors follow one another perfectly and form an uninterrupted chain.

Passing more to the details of the several groups, the author concludes his remarks by suggesting the following classification:—

VI. Asteroidea.

V. Ophiuroidea { Ophiuræ.
Euryalæ.

IV. Echinoidea { Gnathostomata { Palechinoidea.
Regulares.
Irregulares.
Atelostomata.

III. Pelmatozoa { Cystidea.
Blastoidea.
Crinoidea.

II. Holothurioidea { Elaspipoda { Pedata { Aspidochirota.
Pneumonophora { Dendrochirota.

I. Synaptida.

Formation of Germinal Layers in *Amphiura squamata*.*—Sig. A. Russo has observed in *Amphiura squamata* that, after several cleavages, a cell-mass of rounded reddish cells may be easily distinguished; these are grouped symmetrically. The blastula which next appears is very characteristic; its cells are laid down in regular order, become greatly elongated and form a germinal bladder with a rather narrow lumen. The protoplasm of these cells is distinguished by the intensely red coloration of their central part, while the peripheral is yellowish, transparent, and contains a large nucleus. This differentiation of the protoplasm of the cells of the blastula, which precedes the formation of the endoderm by delamination, has been observed in other groups, but it is never so striking as it is here. The red substance is derived from the elements of nutrient yolk.

This mode of formation is closely related to the conditions of development; in all cases where there is a free-swimming blastula there is unipolar endoderm-formation, corresponding to the direction of the swimming; where development goes on in a limited space there is multipolarity. In *Amphiura* development is effected in the body of the mother. The mesoderm is formed by delamination from the ectoderm, and appears first in the form of two groups of cells, one on either side of the archenteron. The coelom is formed by the mesodermal cells ranging themselves along one or other of the first two germinal layers.

Morphology of the Cystidea.†—In this essay the late Dr. P. Herbert Carpenter set himself to show that the dorsal eup of many Cystids is composed of plates which correspond respectively to the infrabasals, basals and radials of a Crinoid. Generalizing from this he expresses the very strongest conviction that the basal and radial plates, and probably also the dorso-central, constitute a fundamental part of the organization of every Echinoderm, except, perhaps, the Holothurians. Even in these it may be found that the plates have the same relation to the right enterocoel in the larvæ of the heavily-plated Psolidæ as they have in other Echinoderms. He takes the opportunity of answering criticisms against his own views, or criticizes propositions of fellow-workers; *inter alia* he objects to the view that palæontology is to be the absolute arbitrator in all phylogenetic discussions, and shows how untenable such a position is. He takes occasion to point out that much of the recent German work on Echinoderms is vitiated by an ignorance of the literature of the subject.

Arctic Comatulæ.‡—The late Dr. P. Herbert Carpenter has a notice of some Arctic Comatulæ; evidence is brought forward to show that *Antedon proluxa* is not, as has been suggested, a full-grown form of *A. tenella*; the distinctness of *A. quadrata* has also been challenged owing to the resemblance between its young stages and those of *A. Eschrichti*; the mature forms are, however, very distinct.

Crinoids from the neighbourhood of Madeira.§—Dr. Carpenter also published notes on some Crinoids obtained by Mr. J. Y. Johnson;

* Zool. Anzeig., xiv. (1891) pp. 405-7 (3 figs.).

† Journ. Linn. Soc. Lond., xxiv. (1891) pp. 1-52 (1 pl.).

‡ *Id.* cit., pp. 53-63 (1 pl.).

§ *Id.* cit., pp. 64-9.

though not new they are interesting from the point of geographical distribution. The species were *Pentacrinus Wyrville-Thomsoni*, *Antedon lusitanica*, *A. phalangium*, the discovery of which at 500–700 fathoms more than doubles its bathymetrical range, and *A. Dubeni*.

Cœlenterata.

Claus and the Development of the Scyphomedusæ.* — Prof. A. Goette gives this title to a pamphlet in which he answers Prof. C. Claus's criticism of his researches on the development of *Aurelia aurita* and *Cotylorhiza tuberculata*. As Goette claims, in his embryological memoir, to have upset almost all that Claus has written on the subject, and as Claus says that he cannot trust Goette's figures, there is naturally occasion for some polemical discussion, of which, however, the Germans have not yet learned to make a fine art. Perhaps for us, who can here express no opinion, the most profitable thing to do is to contrast the views of the two zoologists.

According to Claus.

According to Goette.

Gastrulation.

The endoderm of *Aurelia* is formed by a sac-like invagination of the blastosphere. [But subsequent modifications of this conclusion leave a somewhat confused impression, for he appears to admit the immigration of scattered cells and describes the endoderm as a solid, compact mass of cells.]

The endoderm of *Aurelia* is formed by successive immigrations of cells or groups of cells from the wall of the blastosphere.

The Œsophagus of the Scyphostoma.

The ectodermic invagination at the free end of the fixed larva is again evaginated and forms only the mouth and its disc. [But again, by modifications of this conclusion, Claus approaches if he does not actually accept Goette's interpretation.]

The ectodermic invagination at the free end of the fixed larva persists as the œsophageal tube.

The Gastric Pouches.

Claus at first denied the existence of gastric pouches, but he has, since the publication of Goette's investigations, recognized their existence and calls them as Goette did, without, it seems, recognizing their discoverer.

As diverticula of the primitive gut two pairs of gastric pouches (*Magentaschen*) are formed.

* Leipzig, 1891, 64 pp. and 24 figs.

According to Claus.

The Septal Funnels.

Claus described the longitudinal muscles of the Scyphostoma as solid strands, but now he recognizes that they arise as Goette described, though he does not admit the accuracy of the term septal funnels, nor the homology between septal funnels and subgenital cavities.

The Tentacles and the Radial Symmetry.

Claus derived the axial part of the tentacles from the endoderm of the stomach, and regarded the two primary gastric pockets as these axes. The majority are interseptal, but the four inter-radials are septal; and so on. But Claus has now corrected these conclusions, adopting those of Goette.

Claus at first found the determination of the radial symmetry in the tentacles, but he now distinguishes a peripheral (tentacular) from an inner (antimeral) segmentation, the latter depending on the gastric diverticula.

The Morphological Import of the Scyphostoma.

The Scyphostoma is in its structure a hydropolyp with gastric folds, and is without the essential characteristics of an Anthozoon — œsophagus, septa, gastric pouches, and only interseptal tentacles.

The Scyphostoma, until the beginning of strobilation, is without the essential characteristics of a tetrameral or octomeral or polymeral Scyphomedusa.

According to Goette.

The longitudinal muscles arise in the walls and solid outgrowths of septal funnels which grow from the ectoderm of the oral disc. Moreover, these septal funnels are really continuous and identical with the subgenital cavities of the Medusa.

All the tentacles of the Scyphostoma arise from the gastric pouches; the "septal tentacles" arise from the lateral corners of the third and fourth gastric pouch, and only subsequently come to lie over the septa; the contrast which Claus draws between the wholly interseptal tentacles of Anthozoa and the partly interseptal tentacles of the Scyphostoma is therefore mistaken.

The symmetry of the Scyphostoma is defined by the four gastral pouches, and repeated in septa and gastral folds.

The Scyphostoma is never like a simple hydropolyp, or even like one provided with gastric folds, but it has, in its ectodermic œsophagus, in its septa, gastric pouches (folds and grooves), and interseptal tentacles, the structure of an Anthozoon.

But this structure lasts only for a short time, for in the eight-armed stage at latest the Scyphostoma is modified into a Medusa.

Classification of Scyphomedusæ.*—Dr. E. Vanhöffen objects to Claus's definition of the terms "octomeral" and "tetrameral," and his application of them to the classification of Scyphomedusæ. Claus calls those Medusæ tetrameral which have the umbrellar margin segmented into four parts; Vanhoffen calls those Medusæ tetrameral which have four congruent parameres. Nor is there agreement as to the use of the terms paramere and antimere, which Vanhoffen employs as Haeckel did, whilst Claus gives them new connotations. According to Vanhoffen, all Medusæ are tetrameral and tetraradiate, being composed of four parameres with four radii and four planes of symmetry. He divides the Scyphomedusæ into Cathamnata and Acathamnata, the former including Charybdeidæ, Lucernaridæ, Depastridæ, and Tesseridæ—all with "septal-knots," solid tentacles, and simple oral tube, the latter including Semæostomæ and Rhizostomæ—without "septal-knots," with hollow tentacles (if any), and strongly developed oral arms.

Classification of Anthomedusæ.†—Dr. E. Vanhöffen proposes the following classification of the Anthomedusæ, which he defines as craspedote Medusæ, the generative products of which lie in the ectoderm of the gastric cavity:—

- I. CODONIDÆ. Gonads not disconnected, forming a circular mantle around the gastric cavity.
 1. Syncorynidæ (Sarsiidæ). Medusæ developed from *Syncoryne* and similar polyps, with a regular radially developed umbrella and four well-developed tentacles; *Sarsia*, *Dipurena*, *Corynetes*.
 2. Pennariidæ. Medusæ developed from *Pennaria* with regular radially developed umbrella, and four rudimentary tentacles; *Globiceps*.
 3. Corymorphidæ. Medusæ from *Corymorpha* and similar polyps, with radial or more or less irregularly developed bilateral umbrella, with four, two, one or no tentacles; *Amalthæa*, *Hybocodon*, *Euphysa*, *Diconodium*, *Ectopleura*.
- II. OCEANIDÆ. Gonads four or in four pairs, interradiæ.
 - A. *Cælomerinthia*. Tentacles hollow, highly contractile, with small endodermal cells inclosing a wide lumen.
 4. Amphineuridæ. With numerous marginal lobes appearing like tentacular rudiments placed between a few well-developed tentacles; *Stomatoca*.
 5. Tiariidæ. With numerous well-developed tentacles; *Dinema*, *Conis*, *Tiara*, *Turris*, and *Catablema*.
 - B. *Pycnomerinthia*. Tentacles solid, almost completely filled with large endodermal cells.
 - a. Monorenemata. Tentacles simple and separate.
 6. Dendroclavidæ. Sessile urticating knobs at oral margin; *Turritopsis*.
 7. Podocorynidæ. Stalked knobs, short oral tube; *Cytæis*, *Thamnitis*, *Cubogaster*, and *Dysmorphosa*.
 8. Thamnostomidæ. Stalked knobs, very long oral tube; *Thamnostylis*, *Thamnostoma*, and *Limnorea*.

* Zool. Anzeig., xiv. (1891) pp. 244-8.

† Tom. cit., pp. 439-46.

- β. Lophonemata. Tentacles simple and arranged in tufts.
 9. Bougainvilleidæ. Stalked urticating knobs at oral margin ;
Margelis, *Hippocrene*, and *Rathkea*.
 γ. Cladonemata. Tentacles compound, pinnate or branched.
 10. Pteronemidæ. Tentacles pinnate ; *Pteronema*, *Ctenaria*,
Zanclæa, and *Gemmæria*.
 11. Dendronemidæ. Tentacles branched ; *Cladonema* and
Eleutheria.

Saphenia mirabilis.*—Among the valuable rarities lately found near Plymouth, Mr. J. T. Cunningham records this interesting Medusa, several hundreds of which were obtained. Called *Goodsiria mirabilis* by Strehlitz Wright, who found three specimens in the Firth of Forth, it has never again been seen till now ; and its hydroid stage still remains to be discovered.

Myriothela phrygia.†—Mr. W. B. Hardy has had the opportunity of studying this interesting hydroid at Plymouth. In the proximal or gonophore-bearing region of the blastostyles the ectoderm is composed of varied elements, and differs in appearance at different seasons. It is most complex and thickest in spring and early summer, but in autumn it is not only much thinner, but presents the appearance of being exhausted. A characteristic feature of the spring ectoderm is the presence of small cells, which disappear in the autumn ; the author cannot but think that their disappearance is connected with the active formation of gonophores during the summer months. These special small cells occur in little groups, and frequently betray signs of active proliferation. As they are absent from other parts of the body, and have a peculiar relation to the gonophores, they may be justly looked upon as preformed sexual elements. The process of budding appears to be somewhat remarkable ; when a bud is about to be formed the ectoderm-cells lose their defined characters, proliferate, and give rise to a bulging mass of amorphous tissue ; the thick supporting lamella becomes absorbed, and the endoderm cells likewise proliferate and take on an amorphous character ; the result is a kind of blastema in which the limits of ectoderm and endoderm are not to be distinguished. As this grows the elements lose their distinctness and become highly charged with spherical masses of stored nutriment, resembling in many points the nutritive spheres of the general endoderm. From this the young *Myriothela*, which early loses all connection with the body of its parent, is developed.

In its early stage the formation of a gonophore is essentially similar to that of a bud, but in this case a group of the primitive germ-cells make their way into it. These primitive cells pre-exist as free cells, having lodgment in the tissues of the adult, and only travel into the abortive bud (gonophore) which is their place of final development. At first the male are indistinguishable from the female gonophores.

Mr. Hardy gives a detailed account of the endoderm of *Myriothela*, which may be divided into several regions. There is an oral region characterized by the presence of sense-cells and cilia in its upper part

* Journ. Mar. Biol. Ass., ii. (1891) p. 194.

† Quart. Journ. Mic. Sci., xxxii. (1891) pp. 505-37 (2 pls.).

and of numerous glandular cells (the "goblet-cells") in its lower part; a median zone is characterized by the presence of numerous gland-cells; while the blastostyles and the region of the foot have the endoderm almost exclusively composed of vacuolate cells, usually loaded to the full with stored nutritive material in the form of nutritive spheres. The nutriment formed in the enteron appears to be conveyed through the organism by means of the somatic fluid.

Tectological Studies on Hydroids.*—Dr. Hs. Driesch finds that the main stem of *Antennularia* is formed from an indefinite number of tubes inclosed by ectoderm and endoderm, and communicating irregularly. The plumules are arranged in alternating whorls, varying in number within definite limits in the different species, and increasing as the colony grows older. There is no relation between the number of tubes and the longitudinal series of plumules. The young form of *Antennularia* is for the most part plumularoid.

Origin and Development of the Reproductive Cells in Tubularia.†—Dr. A. Brauer, having investigated *Tubularia mesembryanthemum*, finds that the generative cells arise from interstitial cells of the ectoderm in the gonophore-stalks. Near the origin of a gonophore they pass into the endoderm, and migrate thence to the place where they mature, namely, the ectodermic manubrium (*Glockenkern*). The form and position of the ovum in the gonophore vary much. The segmentation may take place in one of two ways. Each nuclear division may be followed by cell-division; or it may be that at first only the nuclei multiply and that this is followed by a gradual segmentation which begins at the directive pole and extends towards the opposite side. In the first case, a coeloblastula is formed, and the endoderm is established by division of the blastoderm cells. In the second case the formation of the endoderm begins before the segmentation is finished. The endoderm arises in a multipolar fashion; its cells obliterate the segmentation-cavity, and there results a many-layered solid embryo. This has been erroneously termed a morula, for it represents not the final result of segmentation, but the two-layered embryo. By division the ectoderm forms the interstitial layer. The tentacles are incipient before the appearance of the central cavity which is formed by diffuence of endodermic cells. As the two layers are histologically differentiated, the supporting lamella becomes recognizable.

Porifera.

Siliceous Spicules of Geodia.‡—Dr. R. v. Lendenfeld directs special attention to a more or less close network of freely projecting spicules which he has found in Adriatic *Geodias*, and which have, as yet, been only slightly described. At a depth of from 1.5 to 3.5 mm. above the surface lie the centres of these spicules, whence the branching-rays are given off; the shafts of the spicules are long, thin and curved. The author concludes that the primary axis of the *Tetraxonia* is homologous with the single axis of the *Monaxonia*.

* *Jenaische Zeitschr. f. Naturwiss.*, xxv. (1891) pp. 467-79 (3 figs.).

† *Zeitschr. f. Wiss. Zool.*, lii. (1891) pp. 551-79 (3 pls.).

‡ *Zool. Anzeig.*, xiv. (1891) pp. 207-9.

Protozoa.

Organization of Amœbæ.*—Prof. R. Greef calls attention to the presence of motor fibrils in the exoplasm of *Amœba terricola*. He fixed active, strong and large examples of *A. terricola* by suddenly treating them with osmium, and examined them either directly after washing with water or after treatment for a short time with weak spirit. If the pseudopodia of a multinucleate terrestrial *Amœba* so prepared are examined with high powers, they and the whole body may be seen to be surrounded by a distinct doubly-contoured tegumentary layer, which is sharply marked off from the underlying exoplasm. Highly refractive dots may be followed inwards, and may be seen to be arranged with a certain regularity. If the exoplasm be examined further in there may be seen here and there fine continuous filaments which traverse this zone in a radial direction; with care it will be seen that the filaments are connected with the bright dots. Prof. Greef cannot doubt that we have here to do with muscular fibrils which traverse the contractile outer zone in a radial direction, and are inserted into the inner surface of the outer "skin." In the ordinary uninucleate *A. terricola* the fibrils are much finer and difficult to follow.

It is suggested that there are various phenomena in other Sarcodina which can be brought under this head—as the axial filaments of the Heliozoa, which are perhaps the true motors of the pseudopodia, and the axial structures in the tentacles of Acinetæ and others.

Terricolous Amœbæ.†—In another communication Prof. R. Greef dealt with the structure of the *Amœbæ* found in mould. He is confident of the presence of a distinct cuticle; if one adds a weak solution of methylen-blue it may be seen that, as soon as the colouring matter touches the surface, there is at first a fine blue band. Soon the colouring matter makes its way into the exoplasm, and then the stain shows up by the blue folds and grooves which indicate the presence of a cuticle, moved by the underlying exoplasm. An excellent view of the cuticle may be obtained by killing the *Amœba* with osmium and immediately adding methylen-blue solution. On various occasions the author has observed indications of ecdysis or exuviation. Nutrition is effected at points where there is a temporary lesion.

The author insists on the distinction between exoplasm and endoplasm, urging that they differ in organization as well as in physiological significance. The exoplasm is, in the living *Amœba*, perfectly homogeneous, hyaline and colourless; there is nothing comparable to vacuoles.

While the exoplasm is the motor zone of the *Amœba*-body, the endoplasm has quite another character, both in organization and in function. It is soft and fluid, and follows the contractions of the outer zone, without taking any apparently active part in the movements of the body. The most important constituent of the endoplasm and that which gives it its peculiar character are the granules. Some of these are easy and others are very difficult to see; the latter have, in fact, been hitherto overlooked; these the author calls "glanzgranula." In terrestrial *Amœbæ* they are generally spherical in form, and they are surrounded by a fine,

* Biol. Centralbl., xi. (1891) pp. 599-601, 633-40.

† Tom. cit., pp. 601-8.

clear space which does not appear to be a vacuole. The author recommends the close study of these constituents of amoeban organization. The other granules are distinguished as the elementary, since they are believed to be proper elements of the protoplasm; they are considerably larger than the "glanzgranula," very feebly refractive, extremely pale, and only to be detected during life by means of good immersion-lenses. Staining experiments show that these granules have a striking resemblance to a cell *in petto*.

The author has given considerable attention to the phenomena exhibited by the contractile vesicle, which, in the terrestrial *Amœbæ*, is of very large size; he comes to the conclusion that the fluid is not driven out of the body, but into it, and he, therefore, regards this vesicle not as an excretory apparatus, but as one that is, in the first place, circulatory and respiratory. The vesicle, as it collects the fluid in the endoplasm, comes near to the surface of the cell, where an exchange of gases can be effected. The fresh oxygen is driven through the body on the contraction of the vesicle. The passage of the fluid through the cell serves also to prevent the drying up of the protoplasm.

In conclusion, Prof. Græf gives a revision of the terrestrial *Amœbæ*, of which he recognizes five species; three of these are uninuclear; they are *A. terricola* Gr., *A. similis* sp. n., *A. sphæronucleosus*, with which he associates his formerly described *A. granifera* and *A. gracilis*; this last is generally much smaller than the others. The two multinuclear species are both new, and are called *A. fibrillosa* and *A. alba*; the small forms of the former have twenty to fifty nuclei, and the larger one hundred and more. In the latter species the nuclei are also very numerous, but they are larger than in *A. fibrillosa*, and always have ten or twenty nucleoli.

The Animal-like Nutrition of some Peridiniadæ.*—Herr A. J. Schilling describes how one of the naked fresh-water forms—*Gymnodinium hyalinum* sp. n.—feeds upon Chlamydomonads. It loses its cilia and gives off amœboid processes, which engulf the monads. This discovery corroborates what has been observed in regard to *Gymnodinium roseolum* (Schmarda), *G. Vorticella* (Stein), *G. spirale* and *G. gracile* (Bergh), and *Polykritos auricularia*. All these are naked forms. But Schilling has also discovered the same mode of nutrition in *Glenodinium edax* sp. n., which is one of the encapsuled types. It seems, therefore, definitely settled that the members of this family, which are without chromatophores, do feed after the fashion of animals.

A new Form of Trichonymphidæ.†—Prof. J. Frenzel describes *Leidyonella cordubensis* g. et sp. n., a representative of the parasitic Trichonymphidæ. It occurs in the hind-gut of *Eutermes inquilinus* (?), in Argentina. A colourless oval organism, from 0.2–0.45 mm. in length, it is contractile and active, especially in its anterior region, which is conically pointed and bears a tuft of undulating cilia almost as long as the whole organism. The cuticle exhibits oblique longitudinal ridges which are continued into a twisted caudal tuft. There is a simple round nucleus, but no micronucleus, nor contractile

* Ber. Deutsch. Bot. Gesell., ix. (1891) pp. 199–208 (1 pl.).

† Arch. f. Mikr. Anat., xxxviii. (1891) pp. 301–16 (4 figs.).

vacuole. With increase of size the parasite degenerates, losing the tuft of cilia and the caudal tuft.

New Monocystid Gregarines.*—Sig. P. Mingazzini describes some new and imperfectly known Gregarines from the Gulf of Naples. The new genus *Polyrabdina* has dimorphic species,—nematoid and pyriform, the former elongated and fusiform with very numerous longitudinal striæ on the cuticle, and includes *P. Spionis* (= *Gregarina Spionis* Köll.), *P. Cirratuli* (= *Gr. Cirratuli* Lank.), and *P. Serpulæ* Lank. The new genus *Esarabdina* has also dimorphic species of nematoid form, and includes *E. Terebellæ* (= *Gr. Terebellæ* Köll., *Monocystis Telepsavi* Stuart), and *E. Synaptæ* sp. n. The new genus *Nematoides*, elongated and fusiform, truncated anteriorly, pointed posteriorly, is represented by *N. fusiformis* sp. n. from the intestine of *Balanus perforatus*. In the genus *Urospora*, the species *U. longicauda* (= *U. Nemertis* Köll.) is redescribed. The new genus *Pachysoma*, quadrangular in form, is established for *Gregarina Sipunculi* Köll.

Malarial Infection and the Hæmatozoa of Laveran.†—From observations made on thirty-three cases of malaria in Texas Dr. G. Dock has verified the presence of the plasmodia in the blood. The author's attention was chiefly devoted to the ectoglobular form of the parasites, which, like the endoglobular parasites of tertian ague, develop from small spheroidal hyaline bodies, but their development seems to be more rapid, and does not appear to stand in direct connection with the outbreak of the fever. In the plasma they may be observed singly or in collections, and show a dark granular pigment usually located towards their peripheral portions, but occasionally lying more centrally. From these bodies arise the flagellate forms, a condition preceded by lively movements in the pigment-granules. The filament protruded is usually hollow, occasionally pigmented, and always mobile. Sometimes a kind of budding was observed, and this ended in the production of an offspring-parasite resembling the mother in the possession of flagellum and pigment. The nucleoid body of the maternal parasite did not participate in this process of gemmation.

These parasites seem to be connected with the atypical forms of malaria. Their numbers were found to vary rather with the particular individual than to have a relation to the stage of the disease in the same person.

The endoglobular form seems to be regarded by the author only as a "sport," or variety of an organism which, under specially favourable conditions, passes into the typical malaria parasites, and may also pass into this form.

Parasitic Protozoa.‡—Dr. M. Braun has a report on recent advances in our knowledge of animal parasites. B. Solger § has a notice of a new Gregarine from the enteric canal of *Balanus improvisus*, which is distinguished by its circular contractions. *Blanchardia cypricola* g. et sp. n. is an enigmatic form which perhaps belongs to the Sporozoa;

* Atti R. Accad. Lincei—Rend., vii. (1891) pp. 229-35.

† Med. News, July 19th, 1890. See Centralbl. f. Bakteriöl. u. Parasitenk., x. (1891) p. 254.

‡ Biol. Centralbl., x. (1891) pp. 389-92.

§ MT. Ver. Neuvorpommern, xxii. (1890) 4 pp.

it is found in an amœboid or unencysted stage in various parts of the body of *Cypris candida*. The Myxosporidia of freshwater or marine Fishes have been studied by A. Railliet,* Pfeiffer† and Perugia‡; L. Cuénot§ describes a series of parasitic Protozoa from Echinoderms; ten belong to the ciliate Infusorians, and among these are *Uronema echini* from *Strongylocentrotus lividus*, *U. digitiformis* from the skin of *Asterias glacialis*, *Hemispeira asteriasi* from the dermal branchiæ of the same; *Lichnophora Auerbachii* was found on numerous marine animals; *Trichodina synaptæ*, *T. antedonis*, *Rhabdostyla arenaria* (from *Syn. inhærens*), and *Vorticella amphiuuræ*, are new species. Of Dinoflagellata *Prorocentrum micans* was found in the intestine of *Antedon rosacea*, while four Sporozoa were reported from *Syn. inhærens*, *S. digitata*, *Holothuria tubulosa*, and *Echinocardium cordatum*.

Classification of Sporozoa.|| — Sig. P. Mingazzini discusses the affinities between Sarcosporidia and Microsporidia, as regards their distribution, the form and size of their spores, their mode of development, and their adult characters. He concludes that the two groups must be united, and recognizes (1) Gregarinida, (2) Myxosporidia, (3) Sarcosporidia (including Microsporidia), and (4) Hæmosporidia (the parasites of the blood of Vertebrates), as the four well-defined orders of Sporozoa.

Chlamydomonads.¶ — Prof. Goroschankin has endeavoured to clear up the classification of the genus *Chlamydomonas*. He describes *Chl. Reinhardi* Dangeard, *Chl. De-Baryana* sp. n., *Chl. Perty* Gor., *Chl. Steinii* Gor., *Chl. Kuteinikowi* sp. n., *Chl. multifilis* Fresenius, *Chl. reticulata* sp. n., *Chl. Ehrenbergii* = *Chl. morieri* Dangeard, *Chl. pulvisculus* Ehrenberg, *Diselmis viridis* Dujardin, and *Chl. Metastigma* Stein.

In the Chlamydomonad genera *Phacotus*, *Chlamydococcus*, and *Chlorogonium*, the asexual individuals produce small, biflagellate, naked zoospores or planogametes, which conjugate by their apices or laterally, and eventually form zygotes. The conjugation is like that of *Pandorina Morum* or *Stephanosphaera pluvialis*. But in the genus *Chlamydomonas* there is considerable variety. Thus, in the first five species mentioned above, the conjugation is like that in the other genera of Chlamydomonads already described. In *Chl. reticulata*, *multifilis*, and *Ehrenbergii*, however, the gametes are enveloped in membranes, which in various ways they cast off before or during conjugation, while in *Chl. Braunii* the membrane is retained. In *Chl. multifilis* and *Chl. Ehrenbergii* the two conjugating individuals are often markedly dimorphic. "But there are all possible gradations of sexual differentiation between nearly related forms, and even within the same species."

* Bull. Soc. Aquiculture de France, xv. (1890) pp. 192-8.

† Virchow's Archiv, 122 (1890) pp. 552-73 (1 pl.).

‡ Bollet. Scient., xii. and xiii. (1890-1).

§ Rev. Biol. du Nord, iii. (1891) 1 pl.

|| Atti R. Accad. Lincei—Rend., vii. (1891) pp. 136-41.

¶ Bull. Soc. Imp. Nat., 1891, pp. 101-142 (3 pls.).

BOTANY.

A. GENERAL, including the Anatomy and Physiology
of the Phanerogamia.

a. Anatomy.

(1) Cell-structure and Protoplasm.

Morphology and Physiology of the Cell.*—The second part of Herr A. Zimmermann's work on this subject treats of three points,—The chromatophores in etiolated leaves; Protein crystalloids; and The mechanical explanations of the form and arrangement of the cell-membrane.

Sharply defined chromatophores are more common in the colourless parts of bleached leaves than has been supposed; it is only rarely that they are entirely wanting. They vary in all degrees, in size and colour, from normal green chloroplasts, the extreme cases being colourless and only one-fourth the normal size. In some cases chromatophores were found containing vacuoles, and with a nearly normal appearance. The formation of starch is always connected with the presence of chromatophores, and invariably takes place either in their interior or on their surface. This is true even of colourless chromatophores. The mode of treatment employed was to inject the leaves, before making sections, with a 5 per cent. solution of sugar. The fixing material used was corrosive sublimate; the staining reagent iodine-green and ammonia-fuchsin.

The protein crystalloids are often of such regular form that their crystalline nature cannot be doubted; but they are often nearly or quite spherical, and then their nature can only be determined by staining processes. The best reagent for this purpose is acid fuchsin or a double staining with acid fuchsin and hæmatoxylin; the latter is a certain test for distinguishing crystalloids from nucleoles. In some natural orders, such as Olacæ and Scrophulariaceæ, crystalloids were detected in almost every species examined. The author was unable to arrive at any conclusion as to their function. They are abundant in some parasites and insectivorous plants, while entirely wanting in others. During caryokinetic division of the nucleus, the crystalloids are forced into the cytoplasm, where they are apparently absorbed, new ones being formed in the daughter-nuclei. In many plants crystalloids were found within the chloroplasts of the assimilating tissue; in others even within the epiderm. In the Orchidæ the parenchyma of the vascular bundles contains abundance of crystalloids, as well as roundish bodies contained within the chromatophores, which are probably identical with the leucosomes of *Tradescantia*, and belong to the same category as crystalloids. Crystalloids were found in the cytoplasm or the cell-sap in five different plants.

In the formation of the cell-wall two different processes must be distinguished,—the formation of the cell-membrane, and the displacements which take place during its growth. On the whole, Nägeli's theory of intussusception appears the best adapted to explain the complicated phenomena connected with the growth of the cell-wall.

* Beitr. z. Morph. u. Physiol. d. Pflanzenzelle, Heft ii., 102 pp. and 2 pls., Tübingen. See Bot. Centralbl., xlviii. (1891) p. 182. Cf. this Journal, 1890, p. 617.

Unity of Protoplasm.*—Herr J. G. Vogt asserts that the theory of a uniform protoplasm which contains all the future germs of life cannot be maintained in the face of our present knowledge with regard to its properties. The organic elements are the monoplasts; they are the products of chemical processes, and vary in accordance with the conditions under which they are formed. These specifically distinct monoplasts are grouped into polyoplasts, of which there are two chief kinds, those which are composed of similar, and those which are composed of dissimilar monoplasts. All micro-organisms, and all cells of more complicated organisms, are structures of a fourth or higher order, colonies of polyoplasts. The production of species, and every kind of development, is dependent on the power of the monoplasts to adapt themselves to chemical changes.

Minute Structure of the Cell-wall.†—Herr C. Correns has made a series of observations, for the purpose of determining the nature of the striation of the cell-wall, chiefly on epidermal cells of *Hyacinthus orientalis*, and on bast-cells of *Nerium Oleander*, *Vinca minor*, *major*, and *herbacea*, and *Apocynum androsæmifolium*. The striation arises either from unequal thickening or from differentiation. It is usually spiral, the space between the coils varying greatly. The author is unable to determine the cause of the differentiation. The striation of bast-cells is also often due to differences in the amount of water contained, though this is not always the case. In the growth of starch-grains, the question is left undecided whether it is due to splitting, as Nägeli thought, or to the apposition of lamellæ and subsequent differentiation.

Cell-nucleus in Seeds.‡—Herr T. Peters has investigated the condition of the cell-nucleus in the seeds of a large number of plants during their development, rest, and germination. The general results obtained were as follows.

The presence of nucleoles was determined in a large number of cases where they had not previously been detected; as in the cells of the endosperm and embryo of dormant seeds of Conifers (*Picea vulgaris*, *Larix europæa*, *Biota orientalis*); in the reserve-material cells of starchy seeds (*Pisum*, *Vicia Faba*, *Leucojum æstivum*); in those of some seeds destitute of starch (*Pæonia*, *Asphodelus albus*, *Corylus Avellana*). In *Carex* and *Sparganium* there is a considerable increase in the number of nuclei and nucleoles before the formation of the albuminoid-crystalloids and starch. The formation of these crystalloids takes place, in these plants, in the interior of a drop-like collection of proteid substances, by a process of crystallization. In *Ricinus* and *Cucurbita* the crystalloids break up during germination into fragments which are gradually absorbed. In *Carex* the formation of starch commences in the immediate neighbourhood of the nucleus, and it finally completely incloses it. In all germinating seeds a considerable increase takes place in the size of the nucleus, and especially in that of the nucleoles. In the nuclei of

* 'Das Empfindungsprincip u. d. Protoplasma, auf Grund eines einheitlichen Substanzbegriffes,' 8vo, 208 pp., Leipzig, 1891. See Bot. Centralbl., xlvii. (1891) p. 336.

† Jahrb. f. Wiss. Bot. (Pringsheim) xxiii. (1891) pp. 254-338 (2 pls. and 2 figs.).

‡ 'Unters. üb. d. Zellkern in d. Samen während ihrer Entwickl., Ruhe, u. Keimung,' 31 pp., Braunschweig, 1891. See Bot. Centralbl., xlviii. (1891) p. 180.

germinating seeds of *Lupinus* and *Cucumis* there are a larger or smaller number of globular stainable particles which may be regarded as secondary nucleoles.

Tonoplasts.*—Dr. C. Acqua reviews the recent literature on this subject. While admitting the value of De Vries's discovery of the special functions belonging to the membrane of vacuoles, he considers that its importance has been exaggerated by its discoverer, and especially by Went. He disputes the statement that vacuoles can only be formed by the division of others previously in existence, the evidence in favour of which he considers to be very slight. He lays great stress on the evidence in the opposite direction furnished by the observation of Klebs that in *Hydrodictyon reticulatum* the original vacuole remains unchanged during the formation of the very numerous zoospores.

(2) Other Cell-contents (including Secretions).

Formation of Starch-grains and Chlorophyll-bodies.†—M. E. Belzung reiterates his arguments against Schimper's view that the formation of starch-grains is due to special structures which he calls leucites. In the plants observed by him (Leguminosæ) the protoplasm of the undeveloped embryo presents itself in the form of a network which at no time incloses bodies comparable to those termed leucites; the grains of starch come into existence at the free parts of the cell, i. e. in the meshes of the protoplasmic network, precisely like crystals or other similar formations. The meshes of the network contain the cell-sap and inclose the nucleus. The starch-grains are at this period simple. When the embryo is mature, the protoplasmic network has passed into the condition of a granular secondary network, and the starch-grains have united into compound grains. In opposition, therefore, to the generally accepted view that starch-grains are always formed within chlorophyll-bodies, and as a result of the activity of the latter, the author maintains that the starch-grains are first formed, and are the source of the chlorophyll-bodies.

Distribution of Aleurone-grains.‡—Herr F. Lüdtkke has investigated the form, size, and distribution of the aleurone-grains in the seeds of a number of different plants. He confines the term to those bodies which always contain one or more globoids, and may contain crystalloids or crystals.

The solubility of the ground-substance of the grains in water was found to vary in different species. Seeds which contain a large amount of oil, or which also contain cellulose or starch as reserve food-materials, have only a small number of aleurone-grains, at most only three or four in a cell, and these usually adpressed to the wall. But in most seeds the cells are densely filled with aleurone-grains, which become polyhedral in form through mutual pressure. The distribution of the grains also differs in different parts of the same seed.

The author considers the size of the aleurone-grains to be of considerable value in the diagnosis of substances used in pharmacy.

* Malpighia, v. (1891) pp. 106-15. Cf. this Journal, 1888, p. 981.

† Ann. Sci. Nat. (Bot.), xiii. (1891) pp. 5-22 (1 pl.). Cf. this Journal, 1891, p. 362.

‡ Ber. Pharm. Gesell., 1891, pp. 53-9. See Bot. Centralbl., xlviii. (1891) p. 50.

Proteids of the Oat.*—Mr. T. B. Osborne gives an account of the chemistry of the proteids contained in the oat-kernel, which he classifies under the following heads,—(1) those extracted by weak alcohol; (2) those extracted by water; (3) those extracted by cold sodium chloride solution; (4) those extracted by weak potash solution; (5) those extracted by hot sodium chloride solution. Under (1) there are two quite distinct substances, neither of which agrees in composition with Kreusler's oat-gliadin. Under (2) there is an acid-albumin, one or more globulins, and a proteose.

Oil as a Reserve-material in Trees.†—M. J. Suroz has studied the gradual transformation of starch into oil in the autumn, especially in *Tilia*, *Caragena*, *Populus*, *Betula*, and *Prunus*. This process begins to take place in the larger branches from the middle of August to the early part of September, according to the species, and is completed at a period varying between the end of October and the middle of November. The oil thus formed begins to travel from the slender branches to the main stems, and, by about the end of December or beginning of February, has completely left the ultimate branches, the transport taking place apparently both in the bark and in the wood. This condition lasts only for a few days, or at the most a month, when a transport sets in in the opposite direction, the branches becoming in the spring (end of February to beginning of April) as full of oil as they were in the autumn. A transformation now takes place of the oil into carbohydrates—starch and sugar—beginning in the youngest branches. The storing-up of oil occurs in all the amylaceous tissues, i. e. in the parenchyme both of the bark and of the wood.

Rhabdoid, a new Cell-content.‡—Herr J. H. Wakker finds, in the epidermal cells of the tubers of *Tecophilea cyanocrocus* (Amaryllidæ) a peculiar substance, to which he gives the name *rhabdoid*. It has the form of very slender threads, often pointed at both ends, straight, coiled, horseshoe-shaped, or even curved into a circle, usually with a distinct longitudinal striation. The microchemical reactions are given in detail. The author considers the substance not to be a reserve food-material, but rather to serve the purpose of protection against animals. Somewhat similar substances have been found in the gland-cells of the tentacles of *Drosera dichotoma*, in the epidermal cells of *Epiphyllum*, and in those of *Oncidium microchilum*.

Herr H. Molisch § points out that the substance described by Wakker is identical with that previously found by him in *Epiphyllum* and by Mikosch in *Oncidium microchilum*.||

Diastase.¶—According to Herren J. C. Lintner and F. Eckhardt, the ferment of ungerminated grains of barley or wheat is not identical with that of malt. The latter is undoubtedly the product of chemical

* Amer. Chem. Journ., xiii. (1891) pp. 327-47, 385-413.

† VIII. Congress Russ. Naturf. u. Aerzte (Bot.), 1890, pp. 24-8. See Bot. Centralbl., 1891, Beih., p. 342.

‡ Jahrb. f. Wiss. Bot. (Pringsheim), xxiii. (1891) pp. 1-12 (1 pl.).

§ Ber. Deutsch. Bot. Gesell., ix. (1891) p. 270.

|| Cf. this Journal, 1890, p. 619.

¶ Journ. f. Prakt. Chemie, 1890, pp. 91-6. See Bot. Centralbl., xlvii. (1891) p. 362.

changes which accompany germination, and the authors believe that bacteria take no part in its formation.

(3) Structure of Tissues.

Apical growth of the Stem and Leaf in Grasses.*—M. H. Douliot corrects his previous statement that the apical growth of the stem of Gramineæ takes place by means of three apical cells. He now states that there are only two, as in many other families of Monocotyledons. The stem of a typical grass (e. g. *Phragmites communis*) consists of three regions, the epiderm, the cortex, and the central cylinder. Of these one of the two apical cells, the terminal, gives rise to the epiderm, as well as to the leaves; the other, the subterminal cell, to the cortex and the central cylinder. The apparent internodes of the adult stem correspond to the true nodes of the young stem, which have no intercalary growth. In the leaves of grasses the apical growth takes place by means of a single apical cell.

Development of Vessels and Tracheids.†—Herr T. Lange contests the view held by Strasburger and by most writers that mature tracheæ (vessels and tracheids) are entirely destitute of living protoplasm. His observations were made on a large number of Dicotyledons, Monocotyledons, Conifers, and Ferns. The distinction between the two classes of tracheæ upheld by De Bary cannot now be maintained as absolute; there are frequently transitional forms between the two. The method employed for detecting the presence of living protoplasm was that of plasmolysis; the reagent for lignification hydrochloric phloroglucin; for protoplasm methyl-green acetic acid, borax-carmin, or eosin.

With regard to the period at which the protoplasm disappears in the formation of tracheæ, the author classifies the plants examined in the four following groups:—(1) The protoplasm disappears soon after the completion of the processes of thickening of the wall, lignification, and resorption of the septa; (2) The tracheæ contain protoplasm for a considerable time after their maturity; (3) The protoplasm continues through the greater part or the whole of the period of growth; (4) The protoplasm remains in the tracheæ after the close of the period of growth.

It follows from these observations that the protoplasm of the tracheæ is not necessarily entirely consumed in the thickening of their walls. Lignification continues to take place as long as the tracheæ contain living contents. The author maintains further that the protoplasm of the tracheæ may take part in assimilation and metastasis. In the case of vessels, the protoplasts of the separate elements of which they are composed usually coalesce with one another after the disappearance of the septa. Secondary vessels may be developed even in a zone in which growth has not ceased. The growth in length of an internode does not always cease at the same time at all points of a transverse section; the bark and the epiderm often continue to grow after the wood has ceased to lengthen. The formation of secondary vessels in an internode which is still growing in length takes place in aeropetal succession.

* Ann. Sci. Nat. (Bot.), xiii. (1891) pp. 93-102 (1 pl.). Cf this Journal, 1891, p. 210.

† Flora, xlix. (1891) pp. 393-434 (2 pls.).

Nodes and Internodes of the Stem of Dicotyledones.*—M. A. Prunet finds, as a general rule, a marked difference between the vessels of the nodes and those of the internodes, in the vascular bundles of the aerial parts of plants. In the nodes they are generally smaller and more numerous. The parenchymatous tissues, and especially the cortex, are greater in volume in the node; and the medullary rays are larger, or even more numerous. In the underground nodes this difference almost entirely disappears. The woody parts of plants always contain dormant buds connected with the pith by a broad medullary ray which springs from a foliar medullary ray. They are formed at all ages of the plant, and are met with, not only in the axil of ordinary leaves, but also at the base of rudimentary leaves and of bud-scales.

Course of the Vascular Bundles in the Leaves of the Hippocastaneæ.†—According to M. A. Trécul, in *Æsculus* and *Pavia* the primary bundles increase basifugally in the bud-scales, which are abortive leaves. In the leaves themselves, the mode is different in the two genera. In *Æsculus* (*Hippocastanum* and *rubicunda*), the primary vessels belonging to each separate leaflet are formed first of all in the petiole, and descend thence into the stem, and it is only later that other vessels make their appearance on the sides of the median vein of each leaflet. In *Pavia* on the other hand (*macrostachya*, *lutea*, *rubra*, and *californica*), both the primary and secondary veins have frequently a double mode of growth, the upper part appearing first and growing basipetally, and this being then met by the lower portion with basifugal growth; or the order of development is the reverse. The first vessels appear in the veins of the middle portion of the leaf; in the other veins the vessels appear basifugally in the upper part, basipetally in the lower part of the lamina.

Free Vascular Bundles.‡—Herr K. Müller records the existence of free vascular bundles in the leaf-stalk of several species of Umbelliferae (*Heracleum*, *Archangelica*), and Compositae (*Cynara*).

Mucilage-cells of Orchidaceæ.§—Herr C. Hartwich has investigated the constitution of the mucilage-cells in the tubers of Orchidaceæ (*Orchis Morio* and *latifolia*). He finds that a drop of mucilage is first formed round the bundle of raphides in the middle of the cell, which grows, and forces the protoplasm with the nucleus towards the cell-wall, inclosing the protoplasm threads which stretch towards the periphery. Only in the rare cases where the cell does not contain raphides does the formation of mucilage appear not to commence in the middle. The protoplasm threads, observed by Meyer in the mature cells, stretching towards the interior appear to be the result of the action of alcohol. The mucilage takes a yellow colour with iodine and sulphuric acid; with aqueous solution of eosin it is stained yellow-red in young, rose-coloured in older cells, thus affording a contrast to the mucilage of the Cactaceæ.

* Ann. Sci. Nat. (Bot.), xiii. (1891) pp. 296-373 (4 pls.).

† Comptes Rendus, cxii. (1891) pp. 1406-14.

‡ Verhandl. Bot. Ver. Prov. Brandenburg, 1891, pp. viii.-ix. Cf. this Journal, 1890, p. 198.

§ Arch. Pharm., xxviii. (1890) pp. 563-72 (1 pl.). See Bot. Contralbl., 1891, Beih., p. 349.

Sac-cells of Fumariaceæ.*—Commenting on Zopf's most recent researches on the structure and contents of the idioplasts in *Corydalis* and other Fumariaceæ, Herr E. Heinricher repeats the assertion that their most important contents are an oil mixed with other substances, tannin and anthocyan being found in them only exceptionally.

Spicular Cells of Welwitschia.†—Herr C. Bleisch gives details of the structure of the well-known spicular cells of *Welwitschia*, which are encrusted with calcium oxalate, and of similar idioblasts which are found in certain Coniferæ and Nymphæaceæ. They all have a strongly thickened wall, the outer layers of which show the reactions of lignin, the inner layers those of pure cellulose. The crystals are imbedded in a special layer of the cell-wall, which appears to consist of a substance intermediate in composition between cellulose and oxalic acid.

Primary Structure and Affinities of Pines.‡—M. P. Van Tieghem thus sums up the results of his observations on this subject. The root of pines contains vascular bundles of normal form, opposite each of which a deep layer of thick pericycle produces a secretory canal. The non-specialized region of the stem has only pericyclic secretory canals superposed to the bundles, and the leaves of this region have only cortical secretory canals, normally one on each side. The specialized region of the stem has sometimes the same structure, but more often it acquires secretory canals in the primary xylem of the bundles. In this case the short branches and their green leaves are most frequently destitute of these secretory canals in the xylem. In the arrangement of the secretory apparatus *Pinus* more resembles *Picea*, *Larix*, and *Pseudotsuga*, than *Abies*, *Tsuga*, *Cedrus*, and *Pseudolarix*. In their structure *Picea* differs from *Abies*, *Larix* from *Pseudolarix*, and *Pseudotsuga* from *Tsuga*, more than is generally supposed.

Structure of Memecyleæ.§—From a careful study of the structure of all the genera of this family and of that of 130 out of the 135 genera of typical Melastomaceæ, M. P. Van Tieghem concludes that the Memecyleæ should be regarded as a tribe of the Melastomaceæ distinguished by having the phloem inclosed in the secondary xylem. They are again divided into two families, the Mouririæ (*Memecylon*, *Mouriria*) with, and the Pternandreæ (*Pternandra*, *Kibessia*, *Rectomitra*), without sclerites. The remaining genera of Melastomaceæ, constituting the tribe Melastomeæ, with normal secondary xylem, may be arranged under four families, according as there are supernumerary vascular bundles in the cortex only, in the pith only, in both, or in neither.

Anatomy of the Epacridaceæ and Ericaceæ.||—Herr F. Simon compares the minute details of structure in the plants belonging to these two

* Ber. Deutsch. Bot. Gesell., ix. (1891) pp. 184-7. Cf. this Journal, 1891, p. 618.

† 'Zur Kenntn. d. Spicularzellen . . . d. *Welwitschia*,' 50 pp. and 1 pl., Strehlen, 1891. See Bot. Centralbl., xlvii. (1891) p. 312.

‡ Journ. de Bot. (Morot), v. (1891) pp. 265-71, 281-8.

§ Ann. Sci. Nat. (Bot.), xiii. (1891) pp. 23-92 (1 pl.), and p. 374.

|| 'Beitr. z. vergleich. Anat. d. Epacridaceæ u. Ericaceæ,' Berlin, 1890. See Bot. Centralbl., xlvii. (1891) p. 313.

natural orders, and concludes from the comparison that they are nearly related to one another genetically.

(4) Structure of Organs.

Adaptations of Plants to a rainy climate.*—Herr J. R. Jungner describes the contrivances by which trees and shrubs growing in the Cameroon Mountains, one of the most rainy regions on the face of the globe, adapt themselves to the climate. The most common of these adaptations is a leathery consistence of the leaves, which terminate in a sharp point, facilitating the rapid running off of the water from their surface, and thus preventing the growth of fungal, algal, and other parasites which would otherwise develop with extraordinary rapidity on the moist surface of the leaves during the intervals of bright sunshine. Those species which are provided with a bitter latex or other poisonous substances do not need this protection. Plants introduced from other less rainy climates commonly fall a prey to the parasites.

Causes of Variation in Flowers.†—Mr. T. Meehan calls attention to the great variability in the flowers of *Linaria vulgaris* in the United States, both in colour and form, especially in the lower lip of the corolla. This occurs in specimens growing in close proximity to one another, and therefore cannot be due to differences in the environment. The stigma is self-pollinated before the opening of the corolla; as the plant has been introduced from Europe, and all the specimens in any one locality have probably sprung from one, or from only a few, progenitors, the only explanation of the variability which the author can offer is that the plant derives from some pre-natal influence an inherent power to vary greatly.

Male Flower of *Chamædorea*.‡—M. O. Lignier describes in detail the male flower of *Chamædorea elegans* (Palmæ). The more important noteworthy points are the following:—The calyx is entirely independent of the rest of the flower; its fibrovascular system is inserted immediately above that of the rachis of the inflorescence; while the systems of all the other parts of the flower are inserted one above another, though somewhat irregularly. The anatomical insertion of the stamens, in contrast to their apparent insertion, is on the petals, and not on the ovary. The three bundles of the ovary have a reversed orientation, though appearing to represent the dorsal bundles of the carpels. Those of the petals terminate in hypodermal tracheæ.

Protection of Buds in the Tropics.§—Mr. M. C. Potter describes the various special contrivances by which the buds of various tropical plants are protected from a dry atmosphere and from the direct rays of the sun, which he groups under four heads, viz.:—Protection by means of stipules; by the position assumed when young; by shade from older leaves; and by an exudation of gum. Examples are adduced of each of these modes furnished by plants growing in Ceylon.

* Bot. Centralbl., xlvii. (1891) pp. 353–60.

† Proc. Acad. Nat. Sci. Philadelphia, 1891, pp. 269–70.

‡ Bull. Soc. Linn. Normandie, iv. (1890) 1891, pp. 23–30 (1 pl.).

§ Journ. Linn. Soc. (Bot.), xxviii. (1891) pp. 343–52 (3 pls.). Cf. this Journal, 1889, p. 86.

Classification of Fruits.*—Dr. G. Ritter v. Beck proposes the following classification of fruits:—

I. Simple fruits, resulting from a single flower.

A. Dehiscent fruits.

1. Dehiscent apocarp, composed of a single carpel.
 - a. Follicle (*Delphinium*, &c.); b. legume (Leguminosæ and Proteaceæ); c. utricle (*Lemna*).
2. Dehiscent syncarp, composed of several carpels.
 - a. Capsule (*Colchicum* and Cruciferae); b. pyxidium (*Hyoscyamus*, &c.); c. porc-capsule (*Antirrhinum*, *Campanula*); d. utricular capsule (*Chenopodium*, *Naias*).

B. Indehiscent fruits.

3. Indehiscent apocarp; nut, drupe, or berry.
4. Mericarpous apocarp; lomentum.
5. Mericarpous syncarp; (Labiate, Umbelliferae, &c.).
6. Indehiscent syncarp; (*Ulmus*, *Vitis*, &c.).

II. Compound fruits, consisting of two or more flowers.

7. Cone or strobilus (*Pinus*).
8. Connate fruits; (*Lonicera*, *Morus*, &c.).
9. Capitulate fruits (*Castanea*, *Ficus*, &c.).

Seeds of *Vicia narbonensis*.†—In pursuance of his investigations of the morphology and anatomy of the seeds of Papilionaceæ, Prof. L. Macchiati has carefully examined those of this species, and states that he finds the spermoderm to be composed of three different layers, viz.:—(1) An external epiderm consisting of the so-called Malpighian cells; (2) a layer composed of cells with large intercellular spaces, the so-called "columnar cells"; and (3) a parenchyme, the thin-walled cells of which are arranged in a variable number of strata. The first of these layers corresponds to the testa of authors, the second and third to the tegmen. A fourth layer, composed of the "conducting cells" of Le Monnier, does not exist in this, or in other species of the genus. The seed possesses a thin layer of perisperm, derived from the nucellus. The general conclusion of the author is that the spermoderm of Papilionaceæ is not derived from both the primine and secundine of the ovule, but from a modification of the primine only.

Leaves of Aquatic Monocotyledones.‡—M. C. Sauvageau adopts Ascherson's classification of the order Potamogetonaceæ, which includes the greater number of aquatic Monocotyledones, into five families, viz. Zostereæ, Posidoneæ, Potamogetonæ, Cymodoceæ, and Zannichelliæ. He enters, in considerable detail, into the various points of structure of their stem and leaves, and ends with the following general remarks.

The anatomical characters of the leaf are sufficient for the determination of the marine species, of which there are eighteen, belonging to the genera *Zostera*, *Phyllospadix*, *Posidonia*, *Cymodocea*, and *Halodule*. They

* Abhandl. K. K. Zool.-Bot. Gesell. Wien, xii. (1891) pp. 307-12.

† Ricerche s. morph. ed anat. d. seme d. Veccia d. Narbona (1 pl.). See Malpighia, v. (1891) p. 126 and pp. 221-9.

‡ Ann. Sci. Nat. (Bot.), xiii. (1891) pp. 103-296 (64 figs.). Cf. this Journal, 1891, p. 764.

are only partially applicable to the fifty species of *Potamogeton* or to the other freshwater genera. The generic characters derived from the anatomy of the leaf do not always correspond to those founded on the structure of the flower. Contrary to the general opinion, the epiderm is not the sole seat of the chlorophyll in the marine species; it is found also in the cells of the parenchyme, but generally only in small quantities. Cells containing tannin occur in several genera both in the epiderm and in the parenchyme.

None of the marine species examined contain stomates; and this is also the case with the greater number of the freshwater species; but in some species they occur constantly or nearly so.

In the genera *Zostera*, *Phyllospadix*, *Halodule*, and some species of *Potamogeton*, the leaves have an apical opening at the termination of the median vein. This opening is formed at an early period by the disappearance of certain epidermal cells. Its purpose appears to be to place the plant in communication with the surrounding medium, and thus facilitate the exchange of liquid between the plant and the medium. Aquatic plants are permeated by currents of water comparable to the transpiration-current in land-plants; and, when deprived of their roots, they continue to flourish by absorbing water through their leaves.

Pitchers on a Cabbage-leaf.*—M. W. Russell describes several examples of ascidiform structures on cabbage-leaves. The first instance is of a funnel-shaped pitcher which may be compared to a leaf with a long stalk which has been rolled on itself, the margins having become more or less completely united. In the remaining examples we have a pitcher-like structure springing from the upper surface of the leaf. From the arrangement of the vascular bundles the author regards these epiphyllous pitchers as examples of the doubling of a normal leaf.

Leaves of Fossil Banksias.†—Freih. v. Ettingshausen describes a number of remains of leaves from the Tertiary strata of Switzerland, which he refers to the existing Australian genus of Protacæ, *Banksia*, including also in the same genus those described by Heer under the name *Dryandroides*. He concludes that the fossil resembled the existing species of the genus in being polymorphic.

Aerial Roots of Vitis vulpina.‡—Mr. T. Meehan describes the perennial aerial roots of this vine, which he suggests are a survival of an earlier creeping habit by means of rhizome-like stems before it acquired the habit of climbing by tendrils.

B. Physiology.

(1) Reproduction and Embryology.

Morphology of the Phenomenon of Impregnation.§—M. L. Guignard discusses the part played by the "directing spheres" (tinoleucites) in the process of impregnation, and concludes, from the facts observed in *Lilium Martagon* and *Fritillaria*, that the process consists not merely in the coalescence of two nuclei of different sexual origin, but also in the

* Rev. Gén. de Bot. (Bonnier), iii. (1891) pp. 33-42, 337-40 (7 figs.).

† SB. Akad. Wiss. Wien, cxix. (1890) pp. 475-90 (2 pls.).

‡ Proc. Acad. Nat. Sci. Philadelphia, 1891, pp. 275-6.

§ Comptes Rendus, cxii. (1891) pp. 1320-2. Cf. this Journal, 1891, p. 614.

fusion of the two protoplasts, likewise of different origin, represented essentially by the tinoleucites of the male and female cell.

After its outry into the pollen-tube, the reproductive cell of the pollen-grain is fusiform, and is provided with its own specialized protoplasm, the tinoleucites being generally found at one of its extremities. After this cell has divided into two, the anterior of the two, which alone takes part in the process of impregnation, has its two tinoleucites in front of the nucleus. The oosphere, on the other hand, has its two tinoleucites above its nucleus. Consequently, when the male cell penetrates the female cell, the tinoleucites of each cell first come into contact with one another, and fuse together in pairs. The two new tinoleucites thus formed then separate from one another in order to allow the two nuclei to unite in their turn; they are the origin of the poles of the first spindle in the oosphere after impregnation. Fecundation is completed by the gradual fusion of the two nuclei and the division of the mass formed by the chromatic segments of the two sexual nuclei.

The process corresponds closely to that observed by Fol * in the case of animal impregnation.

Function of Extrafloral Nectaries.†—Herr W. Burek describes a number of instances in tropical plants in which the corolla is invariably perforated by insects in order to obtain the nectar, sometimes by the regular visitant of the species, sometimes by altogether foreign insects. In order to counteract the prejudicial effects of this absence of cross-pollination, the species so affected tend to vary in two directions,—towards the formation of extrafloral nectaries, which attract ants to destroy the injurious visitors, and towards contrivances for self-pollination. Several tropical species are described in which the extrafloral nectaries are situated, for this purpose, in close proximity to the flower. Among those in which arrangements adapted for self-pollination have been developed are several species of *Pharbitis* and *Ipomœa* belonging to the Convolvulacæ. Extrafloral nectaries are further described in the following plants:—*Memecylon ramiflorum*, species of *Nepenthes* (on the outer side of the pitcher, attracting a considerable number of ants), *Trichosanthes tricuspidata*, and several species of *Smilax*.

Polyembryony in Clusiaceæ.‡—In a monograph of the morphology and anatomy of this order of Dicotyledons, M. J. Vésque records several instances of polyembryony in different species of *Clusia*. In all cases one of the embryos is much larger and more perfectly formed than the rest; in the other embryos—in one instance there were as many as six—the cotyledons are either entirely wanting or are very small.

Self-fertilized Flowers.§—Mr. T. Meehan adduces reasons for believing that a large number of Composite are self-pollinated, and that the explanation offered by Darwin and others of the conspicuous sterile ray-florets—viz. to act as signal-flags for the attraction of fertilizing insects—is inadequate. The author has observed pollen-tubes entering in the clefts of the bi-lobed stigmas before they open; and the pollen-

* Cf. this Journal, 1891, p. 447.

† Ann. Jard. Bot. Buitenzorg, x. (1891) pp. 75-144 (5 pls.).

‡ Journ. de Bot. (Morot), v. (1891) pp. 328-30.

§ Proc. Acad. Nat. Sci. Philadelphia, 1891, pp. 271-2, 276-83 (1 fig.).

grains, even when large and brightly coloured, frequently pollinate the stigma before any insect, not excepting *Thrips*, can possibly enter the flower. Special examples of self-pollination are given in *Lepachys pinnata* and *Bidens frondosa*; in the latter species we have an arrangement by which the visits of insects are prohibited.

Other examples of habitual self-pollination are given in *Symplocarpus foetidus* (Aroideæ), in which the flowers are frequently proterandrous, and as frequently proterogynous, *Portulaca pilosa*, the flowers of which open only in the sunshine, and yet seed abundantly when grown in the shade, *Cuphea Zimpani* (Lythraceæ), and *Lopezia coronata* (Onagraceæ). *Daphne Cneorum*, on the other hand, of which the flowers seem well-arranged for self-fertilization, never produces seed.

Pollination of Insular Floras.*—From an investigation of the flora of the island of Norderney, belonging to North Friesland, Herr C. Verhaeff agrees in the conclusions of Behrens that, in general, insular floras contain a larger proportion of anemophilous species than continental; and that the number of winged insects being also reduced, the pollination of the flowers is facilitated by their brighter colour. A list is appended of a number of the insular species with their insect-visitors.

Herr R. Alfken† has investigated, with the same object, the flora of the island Juist in the Baltic. He dissents from the statement of Behrens that the number of insects inhabiting islands is small, and gives a list of 597 species found on Juist.

Flowers and Insects.‡—Mr. C. Robertson publishes the instalment of his series of papers on the pollination of flowers and insects relating to the Asclepiadeæ, Gentianaceæ, Polemoniaceæ, Hydrophyllaceæ, Convolvulaceæ, Borraginæ, Solanaceæ, and Scrophulariaceæ.

Fertilization of Araceæ.§—Sig. U. Caleri describes the structure of the inflorescence and spathe of *Arum Dioscoridis*, which form an admirable contrivance for the capture and temporary incarceration of diptera; these insects being the chief, though possibly not the sole, agent in the pollination of the female flowers.

Reverting to the mode of pollination of *Helicodiceros muscivorus*, Prof. G. Arcangeli|| gives a lengthy list of diptera and coleoptera found within the spathe.

Pollination of *Armeria maritima*.¶—Dr. P. Knuth describes the mode in which the flowers of the common thrift are pollinated, which may be either by self-pollination or cross-pollination. They are visited by several species of Hymenoptera, Diptera and Lepidoptera, a list of which is given.

* Abhandl. Naturwiss. Vereins Bremen, xii. (1891) pp. 65–88. See Bot. Centralbl., xlviii. (1891) p. 46.

† Tom. cit., pp. 97–130. See Bot. Centralbl., xlviii. (1891) p. 46.

‡ Trans. St. Louis Acad. Sci., v. pp. 569–98. See Bot. Centralbl., xlviii. (1891) p. 188. Cf. this Journal, 1891, p. 769.

§ Nuov. Giorn. Bot. Ital., xxiii. (1891) pp. 583–8. Cf. this Journal, 1891, p. 68.

|| Tom. cit., pp. 588–95.

¶ Bot. Centralbl., xlviii. (1891) pp. 41–3 (2 figs.).

(2) Nutrition and Growth (including Germination, and Movements of Fluids).

Parasitism and Multiplication of *Cynomorium*.*—Sig. U. Martelli has examined the mode of attachment of *Cynomorium coccineum* to the root of the host-plant. He finds, as in other parasitic plants belonging to the Balanophoracæ and Rafflesiacæ, a thallus belonging to the parasite, and a perforating cone of tissue in which are contained a large number of vessels irregularly disposed and in direct contact with the tissue of the host. In addition to this penetrating cone, rows of cells belonging to the parasite penetrate into every part of the woody tissue of the host, and especially into the cortical tissue of the root; these cells are very frequently of a rose colour. The germinating seeds of *Cynomorium* develope into a thallus in contact with the tissue of the host; but, in addition to this the plant has another mode of propagation. The stem puts out root-like organs in pairs, some of which are provided with root-caps, and are undoubtedly true roots; while others develope into propagula or gemmæ destined to develope into new individuals.

The substance of which the cell-wall of *Cynomorium* is composed resembles that of fungi in resisting attacks of sulphuric acid. A mycorrhiza was observed in the cells of the thallus.

Vitality of Annual Plants.†—Mr. T. Holm records a number of examples of American plants, ordinarily annual, which become perennial under exceptional conditions. They include *Hypericum nudicaule*, *Delphinium Consolidæ*, *Cyperus flavescens*, *Carex cyperoides*, and several species of Graminæ and Cruciferæ. Biennial species also sometimes produce flowers the first year.

Growth of the Cell-wall of Root-hairs.‡—Herr E. Zacharias has investigated the mode of growth of the cell-wall of root-hairs, especially in the cases of *Chara* and of *Lepidium sativum*. He finds, from experiment, that mechanical irritation has no effect in producing thickening of the cell-wall. The thickening takes place at the apex of the hair, and it is here only that the surface increases under normal conditions. The thickening-layers must be regarded as new formations which become deposited within the membrane previously in existence. The author agrees with Askenasy§ rather than with Wortmann, that, although turgor is a necessary condition of growth, it is not the prime factor in causing it; this is dependent on the properties of the protoplasm itself. He is now of opinion that particles of protoplasm become inclosed in the layers of cellulose.

Grafting on underground parts of plants.||—M. L. Daniel has made a series of experiments in grafting, on roots and tubers. As a general rule he finds that it is, in many cases, easy to obtain a graft on a root or underground stem of a plant nearly allied to the graft-plant, and, in some cases, even on a species belonging to a different natural order,

* Malpighia, v. (1891) pp. 97-105 (6 pls.).

† Amer. Journ. Sci. (Silliman), xlii. (1891) pp. 304-7 (1 pl.).

‡ Flora, xlix. (1891) pp. 466-91 (2 pls.). Cf. this Journal, 1891, p. 501.

§ Cf. this Journal, 1890, p. 630.

|| Comptes Rendus, cxiii. (1891) pp. 405-7.

as, for example, *Saponaria* on *Oenothera*. For the graft to succeed, it is not always necessary for the generating layers to be in contact with one another. The failure of grafting is often due to the obstacle presented by the cell-walls of the graft-plant to the passage of certain nutritive substances from the cells of the host to those of the graft. This is especially the case with inulin in the Compositæ.

Torsions during Growth.*—Herr H. de Vries gives a very detailed account of the various kinds of true torsion (Zwangsdrehungen), as well as those of simple torsion in which the axis remains straight, but the appendicular organs are more or less twisted, the original phyllotaxis remaining unchanged. A very large number of cases of true torsion are described, in plants belonging to many orders of Dicotyledones, and to *Equisetum* among Vascular Cryptogams. The various modes are classified as follows:—I. Simple torsions (1) of leaves and leaf-stalks, (2) of naked stems, (3) of leafy stems, (4) of fasciated stems; II. Torsion of trunks; III. Spiral torsions (1) of stems, (2) of roots; IV. Spiral arrangement of leaves usually decussate or verticillate (1) without, (2) with connation of the bases of the leaves; V. Curvatures in a flat plane.

Coalescence of Organs.†—Herr K. Reiche points out that true coalescence of organs—i. e. the union in the course of growth of organs originally distinct—is not a common phenomenon in the vegetable kingdom. In the perianth it occurs but rarely. Examples may be cited in the calyx-teeth of *Fuchsia*, and in the petals of *Tupa salicifolia* (Lobeliaceæ), of *Selliera radicans* (Goodeniaceæ), and of *Carica papaya*. In the stamens it occurs in *Cratægus oxyacantha*, in the staminal tube of *Tupa salicifolia* and other Lobeliaceæ; but not, as stated by Eichler, in the staminal bundles of *Citrus*. In the ovary it is a much more common occurrence, as in the union of the margins of the carpellary leaf in Papilionaceæ, in the siliqua of Cruciferae, and in the fruit of *Mirabilis*.

In the vegetative organs true coalescence may take place between two different organs either of the same or of different individuals, or between a plant and an inorganic substance. In the former case it results usually from the destruction of the periderm and the union of the two cambial zones, as in the process of grafting. The phenomenon is very similar in the case of parasitic plants; but the degree of coalescence between host and parasite varies greatly. In *Cuscuta* the branches of the haustorium perforate the cell-walls of the host without entering into close combinations with them; while in *Loranthus* the union is much closer. Instances of close union between a growing organ and an inorganic substance are furnished by the union of the attachment discs of *Ampelopsis* and *Cissus* to a wall, and of those of *Durvillea* to mussel-shells.

Histology of Fastigation.‡—Herr W. Figdor has subjected the phenomena of fastigation, and of coalescence of growth in general, to

* Jahrb. f. Wiss. Bot. (Pringsheim), xxiii. (1891) pp. 13-206 (10 pls.).

† Flora, xlix. (1891) pp. 435-44 (1 pl.).

‡ S.B. k. Akad. Wiss. Wien, April 9, 1891. See Bot. Centralbl., xli. (1891) p. 319.

a histological examination. He finds that coalescence always depends on a new formation of cells, which combine organically in the same way as they do in an ordinary tissue. The cell-walls of the coalescing cells are living; their protoplasm finely granular; they contain active oxygen.

Influence of Light and Moisture on Growth.*—Without asserting that turgor has no influence on growth, Prof. E. Godlewski maintains that it is by no means the most important factor. It is in the youngest parts of a plant, where turgor does not vary with the presence or absence of light, that growth shows the greatest variation between day and night. The author agrees with Askenasy in attributing a special influence on growth to protoplasm, which is easily understood if we suppose the cell-wall to be permeated with living protoplasm. The solar rays exercise a retarding influence on growth, but not an immediate one; since, in the case of *Phaseolus multiflorus*, the stems lengthen more by day than by night. Any diminution of moisture in the air causes a sudden but transitory retardation, an increase of moisture a transitory increase in the rapidity of growth. A great increase in temperature also causes retardation of growth. The temperature of the soil has scarcely any influence on growth. In etiolated plants the phenomena are very irregular in this respect.

Influence of Atmospheric Electricity on the Growth of Plants.†—From experiments made chiefly on *Lactuca Scariola*, *Zea Mays*, *Triticum æstivum*, *Nicotiana Tabacum*, and *Vicia Faba*, Prof. A. Aloï has arrived at the conclusions that atmospheric electricity exercises a beneficial influence on the growth of plants; that the electricity of the soil has a similar influence on the germination of seeds; and that the less luxuriant vegetation of plants which grow in the neighbourhood of trees is due in great part to the diminution of temperature.

Influence of Depth in the Soil on Germination.‡—Herr Kraus shows that the vigour of vegetation during germination may depend on the depth at which the seed is planted in the soil; when this is too near the surface the seedling is not vigorous. The optimum depth for each species does not depend in any way on the size of the seed. Leguminous seeds are, within certain limits, indifferent to the depth at which they are planted. Vegetative reproductive organs, such as the eyes of potatoes, are subject to the same law.

Action of Poisons on the Germination of the Seeds of the Plants which produce them.§—M. C. Cornevin has investigated this subject, especially in reference to saponine, cytisine, nicotine, and narcotine. In the cases where the poison is formed in the seed, as saponine in those of *Agrostemma Githago*, and cytisine in those of *Cytisus Laburnum*, its presence offers no hindrance to the germination of the seed. Where the poison occurs in some other part of the plant than the seed, as in the latex, the effect of bringing seeds of the same plant into contact with it varies. Seeds of the tobacco plant brought into contact with nicotine

* Anz. Akad. Wiss. Krakau, 1889 and 1890. See Bonnier's Rev. Gén. de Bot., iii. (1891) p. 327. Cf. this Journal, 1890, p. 630.

† Malpighia, v. (1891) pp. 116-25.

‡ Forsch. aus d. Geb. d. Agriculturphysik, 1890. See Bonnier's Rev. Gén. de Bot., iii. (1891) p. 438.

§ Comptes Rendus, cxiii. (1891) pp. 274-6.

either did not germinate at all, or their germination was greatly retarded; while, on the other hand, of the alkaloids contained in the poppy, narcotine, codeine, and narceine stimulated the germination of its seeds, morphine and thebaine appeared to produce no effect, and papaverine retarded the process.

Absorption of Water by Leaves.*—Herr A. Burgenstein has made a series of observations on the absorption of water by the surface of leaves, and comes to the conclusion that, although it may take place to a certain extent, through the epidermal cells, the stomates, and the hairs, it is of no physiological importance, at least as regards the flora of Europe. An exception is furnished by rootless epiphytes, and certain xerophilous plants.

Direct Assimilation of Nitrogen.†—Herren B. Frank and R. Otto give a practical application to their previously recorded conclusion that the leaves of leguminous plants contain a larger proportion of asparagin in the morning than in the evening, owing to their taking up directly the nitrogen of the atmosphere. They recommend that those crops which are cut green for fodder, such as clover, should be cut shortly after sunset. They also point out that, for the same reason, evening is the best time for the pasturing of cattle, especially when the weather is clear and warm in the day-time.

Evolution of Oxygen by Plants at low temperatures.‡—According to experiments made by M. H. Jumelle on certain conifers and lichens, the suppression of assimilation at temperatures below zero C. depends rather on the stoppage of the supply of water than on the low temperature itself. At temperatures reduced as low as -33° and -35° , it was found that branches of *Picea excelsa* and *Juniperus communis* continued to disengage oxygen in diffused sunlight. The same was the case with *Evernia Prunastri* at temperatures between -30° and -20° ; while with *Physcia ciliaris* and *Cladonia rangiferina*—lichens in which the process of assimilation is much less intense at ordinary temperatures—no decomposition of carbon dioxide could be detected at very low temperatures, even in sunshine. It appears, therefore, that with plants which are capable, when moist, of resisting intense cold, the decomposition of carbon dioxide may continue at very low temperatures, long after respiration has ceased.

(3) Irritability.

Sensitiveness of Antherozoids.§—Herr C. Voegler has investigated the sensitiveness of the antherozoids of ferns to malic acid and its compounds. The observations included all families of ferns except the Hymenophyllaceæ, Gleicheniaceæ, and Marattiaceæ.

The structure of the antherozoids was found to be the same in all families of ferns in all essential points, the only variations being in the number of the coils and in the length and breadth of the spiral band.

* JB. Leop. Comm.-, Real.-u. Obergymn. Wien, 1891, 47 pp. See Bot. Centralbl., xlviii. (1891) p. 186.

† Deutsche Landwirths. Presse, xviii. (1891). See Bot. Centralbl., 1891, Beih. p. 340. Cf. this Journal, 1891, p. 370.

‡ Comptes Rendus, cxii. (1891) pp. 1462-5. Cf. this Journal, 1891, p. 634.

§ Bot. Ztg., xlix. (1891) pp. 641-9, 657-63, 673-80, 689-98, 712-7.

Their number was generally less in the earlier than in the later antherids. Their escape from the antherid takes place always in the same way. The lid-cell becomes detached; and the ring-cell then, by its swelling, exercises a pressure on the contents of the antherid, by which the special mother-cells are pressed out of it. In these lie the antherozoids coiled up spirally and enveloped by their cilia. After a short time swelling causes the membrane of the mother-cell to rupture, and the antherozoid escapes. The activity of the antherozoids continues for a period of from 20 to 55 minutes, according to the species; the most favourable temperature is between 15° and 28° C.; both higher and lower temperatures are unfavourable. It is dependent also on the presence of free oxygen and on light.

The proportion of malic acid in artificially prepared solutions which excited the sensitiveness of the antherozoids was uniformly, for all species, about 0.001 per cent. Neutral salts of malic acid produced similar results. Their sensitiveness attains its maximum at the moment of escape from the mother-cell. The balls of mucilage which are ejected from the ripe archegone exercise precisely the same attractive force on the antherozoids; these bore through them in order to reach the neck of the archegone. As a general rule three large balls are first of all ejected, and this may be followed by the ejection of smaller portions.

The mucilage-balls of any species appear to exercise precisely the same attraction on the antherozoids of any species, even belonging to a different genus; so that antherozoids of one species may freely penetrate into the central cell of a different species of fern; but here their progress ends; there appears to be a mechanical difficulty—though of what kind has not been ascertained—in the way of their coalescence with the oosphere of a different species; so that hybridism is very rare in ferns. A large number of antherozoids enter the central cell, but in no case was more than one seen to coalesce with the oosphere; many of those which enter the central cell later again force themselves out of it, to be succeeded in their turn by others. The coalescence takes place in the way described by Strasburger; the antherozoid passes through the hyaline spot of the oosphere into its interior, and there very soon becomes indistinguishable.

Sensitiveness of the Filaments of Mucorini.*—M. F. Elfving has made a series of observations on the sporangiferous filaments of *Phycomyces nitens*, which are extremely sensitive to light and to gravitation. He also records the remarkable fact that they are attracted by a plate of iron or steel of any description, placed at a distance of several centimetres, curving towards it when in a state of active growth. Zinc and aluminium exercise but little influence; platinum, gold, copper, lead, tin, and nickel none at all. He claims also to have determined that the attraction is not the result of magnetism, nor of electricity, nor of luminous or calorific rays, the phenomenon taking place equally in the dark and at ordinary temperatures. It appears to be a specific property of the metal. Combinations of iron, such as magnetite, hematite, and potassium ferrocyanide, are without effect; but similar results are pro-

* Ann. de l'Inst. Pasteur, 1890. See Bonnier's Rev. Gén. de Bot., iii. (1891) p. 362.

duced by some other substances, such as wax, sealing-wax, colophane, silk, cotton, wool, linen, caoutchouc, wood, sulphur, &c., when dry; and by vigorous roots of other plants. On one another the sporangiferous filaments of *Phycomyces* exercise a slight influence of repulsion.

(4) Chemical Changes (including Respiration and Fermentation).

Development of Wheat and Formation of Starch in the Grain.*—M. Hébert has studied the development of the wheat-plant in the light of recent knowledge obtained as to the composition of straw. Certain tables are given which throw some light on the source of the starch in the grain. The straw gum, really contained in the stems instead of the starch or amylaceous substance formerly supposed to accumulate there ready for transportation to the grain, does not appear to be its source. It increases in the straw regularly up to the end of maturation, forming 25–35 per cent. of ripe straw, is insoluble in water, is attacked by acids with difficulty, and requires a long time for transformation into xylose. It is certain that starch is not formed early in the life of the plant and then transported, and it is equally certain that it is not formed by chlorophyll action during maturation, for at that period the leaves are yellow and withered. As to nitrogenous matters, there is an accumulation in the straw and subsequent migration into the grain.

Action of Diastase upon Starch.†—Herr A. Meyer contests Krabbe's statement that the diastase-ferment does not penetrate between the micellæ in channelled starch-grains, and thus cause their dissolution. He finds in many, if not in all cases, the surface of the starch-grains to show splits and crevices before the commencement of their dissolution.

New Fermentation of Starch.‡—Sigg. A. Selavo and B. Gosio state that starch paste which had been kept for four months and had decomposed, acquired an agreeable odour due to the presence of alkyl butyrate, and subsequently an odour of valeric acid was perceptible. This starch paste was found to have the power of inducing the same change in other starch paste. The cause of this change is a bacillus (*Bacillus suaveolens*) which was isolated. The bacillus has no pathogenic properties, will develop on all the usual nutritive solutions, and presents a characteristic appearance in plate cultures; it does not liquefy gelatin. In order to develop spores, the bacillus requires air and a temperature of 22–29°, and a nutritive substance as neutral as possible. It converts starch gradually into dextrin and glucose, with formation of alcohol, aldehyde, formic, acetic, and butyric acids, together with ethereal substances of an agreeable odour.

Alcoholic Fermentation with *Saccharomyces apiculatus*.§—Herr C. Amthor found, from experiments made by fermenting beer-wort with *Saccharomyces apiculatus*, that the maximum volume of alcohol, viz. 1.49 per cent., was reached in about two years, and hence that it was of no practical value for estimating dextrose.

* Ann. Agronom., xvii. pp. 97–115. See Journ. Chem. Soc., 1891, Abstracts, p. 1285.

† Ber. Deutsch. Bot. Gesell., ix. (1891) pp. 238–43. Cf. this Journal, 1890, p. 749.

‡ Arch. Ital. Biol., xiv. See Journ. Chem. Soc., 1891, Abstracts, p. 1284.

§ Chemiker Ztg., 1891, p. 670. See Centralbl. f. Bakteriologie u. Parasitenk., x. (1891) pp. 157–8.

From another series of experiments made with *S. apiculatus* by inoculating it in a medium containing ammonia salts, dextrose, and invert sugar, it was ascertained that a percentage volume of 4.12 was reached in about one year. The distilled alcohol contained fusel oil. The volatile acids consisted of formic acid, acetic acid, and of a small quantity of an acid boiling at 120°-125°. The non-volatile acid contained succinic and lactic acids. The fact that *S. apiculatus* produced in sixteen days 0.79 per cent. by volume of alcohol from beer-wort, and that it took almost one and a half years to produce less than double this quantity, showed that, besides the quickly fermenting dextrose, there must be present other sugars which ferment quite slowly.

Nitrification.*—From a series of experiments carried on in the laboratory with porous bodies, M. H. Bordier has come to the conclusion that the production of nitric acid which takes place in the soil, may, at least to a large extent, be attributed to the oxidizing influence of the air which percolates the interstices of the soil, the circulation of this air being promoted by constant changes of temperature (thermo-diffusion).

γ. General.

Action of the Colours of Flowers on Photographic Plates.†—Noticing that the flowers of *Sicyos angulata* were very largely visited by insects, notwithstanding their small size and light green colour, Dr. P. Knuth has made a series of experiments with a view of determining the relative intensity of the action of flowers of different colours on photographic plates. He found the order of succession to correspond with the curve of the chemical rays of the spectrum, except that the light-green flowers of *Sicyos* and *Bryonia* came out earlier and stronger than would have been expected. Further experiments convinced the author that the phenomenon is due to the flowers of these plants giving out ultra-violet rays; and the inference follows that, as insects can detect tones higher than those audible to the human ear, so they can detect rays of light invisible to the human eye. Direct observations showed that the flowers of *Sicyos angulata* possess about half the intensity of pure white flowers.

Fossil Dicotyledones.‡—M. G. de Saporta records the discovery of some very interesting fossil remains of plants at Cercal in Portugal in strata lying between the Cenomanian and the Neo-jurassic, and incumbent on the latter. They include about thirty-five species, of which about one-half are Cryptogams. Among these the most abundant are several species of *Sphenopteris*, and there is also a remarkable new species allied to *Isoetes*, *Isoetopsis Choffati*. Among Gymnosperms there are five Conifers. Among Monocotyledones were found species of *Poacites*, with grass-like leaves resembling those of *Zostera*, and *Protolemma*, apparently allied to our existing *Lemmas*. But the most interesting remains found were those of a plant which the author calls *Protorhipis Choffati*, with reticulate-veined leaves, and which he regards as representing an archaic and very lowly organized type of Dicotyledones, but

* Mém. Sci. Phys. et Nat. Bordeaux, v. (1890) pp. 185-238.

† Bot. Centralbl., xlviii. (1891) pp. 161-5, 314-8 (12 figs.).

‡ Comptes Rendus, exiii. (1891) pp. 249-53.

slightly differentiated from the Monocotyledones, from which those now in existence may possibly have sprung.

Zoocecidia.*—Herr G. Hieronymus enumerates the galls found on European plants. He classifies them under three heads, viz. :—*Helminthoecidia* (13), *Acaroecidia* (273), *Entomoecidia* (517) arranged under *Hemipteroecidia*, *Dipteroecidia*, *Hymenopteroecidia*, *Lepidopteroecidia*, and *Coleopteroecidia*. Under each species of plant are enumerated the insects which produce galls upon it, and the European distribution, as far as it is known.

B. CRYPTOGRAMIA.

Classification of the Vegetable Kingdom.†—Prof. F. Ardissoni proposes a classification of the Vegetable Kingdom, of which the following are the main features :—

I. PROTHALLOGAMÆ.

1. *Angiogamæ*.

Class 1. *Angiospermæ*.

Class 2. *Gymnospermæ*.

2. *Gymnogamæ*.

Class 3. *Heterosporæ* (*Marsilineæ*, *Sclaginellinæ*).

Class 4. *Isosporæ* (*Lycopodineæ*, *Filicineæ*, *Equisetineæ*).

II. CORMOGAMÆ.

1. *Schistogamæ*.

Class 5. *Charinæ*.

2. *Aulogamæ*.

Class 6. *Sporoginæ* (*Bryinæ*, *Sphagninæ*, *Jungermanniæ*).

III. THALLOGAMÆ.

1. *Telogamæ*.

Class 7. *Cystocarpeæ* (*Florideæ*).

2. *Zygogamæ*.

Class 8. *Esucophusæ* (*Dictyotinæ*).

Class 9. *Blephariphusæ* (*Fucoideæ*, *Vaucherineæ*, *Bryopsidineæ*, *Confervineæ*, *Chytridineæ*).

Class 10. *Ablephariphusæ* (*Peronosporineæ*, *Mucorineæ*, *Zygnemineæ*, *Desmidiineæ*, *Diatominæ*).

IV. AGAMÆ.

Class 11. *Basidiosporæ* (*Agaricineæ*, *Lycoperdinæ*, *Tremellinæ*, *Uredinæ*, *Ustilaginæ*).

Class 12. *Ascosporeæ* (*Tuberineæ*, *Pezizineæ*, *Hypoxylinæ*, *Parmelineæ*, *Saccharomycineæ*).

Class 13. *Myxosporeæ* (*Endomyxaceæ*, *Ceratiaceæ*, *Acrasiaceæ*, *Plasmodiophoraceæ*).

Class 14. *Schizosporeæ* (*Nostochinæ*, *Chroococcoideæ*, *Bacterinæ*).

* Schles. Gesell. Vaterl. Cultur, Ergänzungsheft zum 68 JB., 1890, pp. 49-272.

† Rend. R. Ist. Lombardo, xxiii. (1890) pp. 281-7.

Cryptogamia Vascularia.

Development of Tissues in Vascular Cryptogams.*—M. G. Poirault has investigated the mode of development of the tissues in the vegetative organs of a number of Vascular Cryptogams, especially in the root, stem, and leaf.

The segments which are cut off from the three-sided apical cell of the root, first divide by vertical walls; horizontal walls appear only at a later period. The first wall is that in a nearly radial direction, called by Nägeli the sextant-wall, by De Bary and Van Tieghem the radial wall, which the author proposes to term the "curved wall" (*cloison courbe*). The two daughter-cells thus formed are of unlike form, one four-sided, the other three-sided. The two succeeding walls are parallel to the surface; the outer one, which appears first, is called the "cortical wall," the other the "pericyclic wall" (Nägeli's cambium-wall). The entire segment now forms a layer composed of eight cells, of which the two inner ones are the initials of the central cylinder, the four outer ones of the cortical layer. A somewhat different mode of division occurs in *Equisetum* and *Azolla*.

As regards the division in the stem, *Salvinia*, *Marsilea*, and *Azolla* grow by a two-sided apical cell (not three-sided, as stated by Hanstein in *Marsilea*), and their subsequent development shows great uniformity. The segments are arranged in two rows, and they all exhibit a bilateral symmetry. In *Equisetum arvense* there are always a tetrahedral apical cell and three rows of segments (not four rows, as described by Hofmeister).

In the leaf the author found invariably a two-sided apical cell with two rows of segments. The first division-wall corresponds to that of a two-celled stem-segment. The original segment divides, by a complicated process, into an outer and an inner layer of secondary segments; these again divide parallel to the surface, and thus give birth to the initials of the various tissue-systems.

Structure of Tmesipteris.†—Mr. A. V. Jennings and Miss K. M. Hall describe the more important points in the structure of *Tmesipteris tannensis* (including *T. Forsteri* and *Billardieri*):—viz. those of the axis, including the fibrovascular system of the leaf and of the sporanges. The authors agree with Solms-Laubach, rather than with Eichler and Bertrand, in regarding the whole sporangiferous structure as a modified phyllome, rather than as a special sporangiferous branch. They find the protoplasm of the cells, especially those of the cortex, to be infested with the hyphæ of an undetermined fungus, similar to that described by Treub and Bruchmann in species of *Lycopodium*.

Muscineæ.

Starch in the Aquiferous Tissue of Mosses.‡—Herr M. Dalmer finds the cells of the aquiferous tissue in the columel of the capsule of *Mnium cuspidatum* and other mosses, to be provided with chlorophyll-

* Mém. Acad. Imp. Sci. St. Pétersbourg, xxxvii. (1890) 26 pp. and 5 pls. See Bot. Centralbl., xlviii. (1891) p. 77.

† Proc. R. Irish Acad., ii. (1891) pp. 1-18 (5 pls.). Cf. this Journal, 1891, p. 499.

‡ Flora, xlix. (1891) pp. 460-5.

bodies which contain abundance of starch. These are apparently stored up for the purpose of supplying food-material for the development of the spores, and also probably of the opercule. In *Polytrichum commune* and *Funaria hygrometrica*, on the other hand, no accumulation of starch in the columel was observed.

Algæ.

Ectocarpus.*—Herr P. Kuckuck gives a monograph of the species and sub-species of *Ectocarpus* growing in the Kiel-basin, including one new species, *E. dasycarpus*. Details are also given of the morphology of the species, especially with regard to the structure and development of the unilocular and plurilocular zoosporanges. Intermediate forms between the two occur, especially in *E. penicillatus*.

Plurilocular Zoosporanges of Asperococcus and Myriotrichia.†—Mr. T. H. Buffham describes the hitherto unknown plurilocular sporanges of *Asperococcus bullosus*, and those of *Myriotrichia clavæformis*, of which no description had previously been published.

Development and Classification of Green Algæ.‡—M. F. Gay treats of the development and classification of the Confervaceæ, Ulotrichaceæ, and Pleurococcaceæ. He has specially studied the formation of the various kinds of resting-cells, whether "hypnospores" (aplanospores of Wille) or "hypnocysts" (akinetes of Wille).

The genera of Confervaceæ examined are *Cladophora*, *Rhizoclonium*, and *Conferva*. The thallus of *Cladophora* may be divided into a rhizoid and a cauloid portion, on both of which hypnocysts are formed. Rhizoid hypnocysts occur in *C. glomerata*, which develop into rhizome-like branches or rhizoids; cauloid hypnocysts in *C. fracta* var. *dimorpha* var. n. Their production is induced by unfavourable conditions of germination. *Rhizoclonium* is distinguished from *Cladophora* by its intercalary growth; by the formation of lateral unicellular rhizoids; and by the cells being often uninucleate. Hypnocysts occur. The resting-spores in *Conferva bombycina* are hypnocysts, not hypnospores.

The author adopts Borzi's division of the Ulotrichiaceæ into Chætophoreæ and Ulotrichiæ. In *Stigeoclonium* he describes hypnospores in *S. variable*, hypnocysts in *S. setigerum*; also hypnospores in *Draparnaldia* and *Chætophora*. There are no true *Palmella* or *Protococcus* forms in these genera, and therefore no true polymorphism. *Ulothrix parictina*, *radicans*, and *crenulata* belong properly to *Schizogonium*. A new species, *U. disscta*, is described, growing on the bark of trees. There is no genetic connection between *Ulothrix* and *Pleurococcus* or *Stichococcus*. In *U. subtilis* β *variabilis* the megazoospores escape by gelatinizing of the cell-wall, and not through an orifice. Both hypnospores and hypnocysts occur. *Hormospora mutabilis* is probably a *Ulothrix*.

The Pleurococcaceæ are characterized by being unicellular or multicellular green algæ, which are not propagated by zoospores, but by cell-division or the separation of particular cells. M. Gay divides them into

* Bot. Centralbl., xlviii. (1891) pp. 1-6, 33-41, 65-71, 97-104, 129-41 (6 figs.).

† Journ. of Bot., xxix. (1891) pp. 321-3 (1 pl.).

‡ 'Rech. sur le dév. et la class. de quelques algues vertes,' 8vo, 116 pp. and 15 pls., Paris, 1891.

Pleurococceæ (*Pleurococcus*, *Stichococcus*, *Schizogonium*, *Prasiola*), Dactylococceæ (*Dactylococcus*, *Raphidium*, *Selenastrum*, *Actinastrum*, *Crucigenia*), and Gloeocystæ (*Geminella*, *Gloeocystis*, *Nephrocystium*, *Oocystis*, *Trochiscia*). There is no genetic connection between *Pleurococcus* and *Stichococcus*, nor between the various species of *Schizogonium* and *Prasiola*. The alleged polymorphism of the lower Algæ rests sometimes on inexact description of genera and species, sometimes on a simple external resemblance, sometimes on an inaccurate interpretation.

Chroolepideæ.*—Herr G. Karsten gives a monograph of this family of Algæ, comprising the genera *Trentepohlia*, *Chroolepus*, *Phycopeltis*, and *Cephaleuros* (including *Mycoidea*). Among the points of general structure described, he states that the cell-wall varies in thickness according to the greater or less dryness of the habitat. The characteristic pigment of the cell-sap, hæmatochrome, which serves a purpose of protection to the other cell-contents, is specially described. The vegetative organs show a great variety in their degree of complexity; the two first-named genera consisting of filaments, the two last-named of plates of cells. In the epiphyllous species of these two genera, each swarm-spore is transformed into an attachment-disc, which develops into a large flat thallus. The swarmspores are formed in two kinds of sporanges, globular and hooked, the latter being especially adapted for development in the air. Conjugation of swarmspores was observed by the author only in one species of *Phycopeltis*, and is believed by him not to be of a sexual character, since each of the two swarmspores is able to develop into a new individual without the assistance of the other. Five new species of *Trentepohlia* are described, two of *Phycopeltis*, and five of *Cephaleuros*, mostly from Java.

New Prasiola.†—Under the name *Prasiola japonica*, Dr. R. Yatabo describes a new species which grows in rapid streams in mountainous parts of Japan, attached to stones. It is collected in large quantities by the inhabitants, and used as an article of food in the same way as species of *Ulva*.

Cænogonium.‡—M. P. Hariot holds that *Cænogonium dialeptum* is a perfectly well-characterized alga. Sporangies have been found which by their structure recall certain species of *Trentepohlia*. Sometimes the primary cells of a lateral branch dilate and become ampulliform. In the mode of ramification and in the dimensions of the organs, *C. dialeptum* resembles *C. simplex*, and the author's view is that these species ought to be united under the name *Trentepohlia dialepta* (Nyl.) Hariot. Furthermore he considers that *C. diffractum* ought to be *T. diffracta* Har., and that *C. effusum* is identical with *T. scitifera* Farl.; while *C. tenuissimum* ought to be ranged with *C. dialeptizum* Siron.

Actidesmium.§—Herr P. F. Reinsch gives further details of the life-history of this very rare and remarkable genus of Protococcaceæ, which exhibits affinities, in different directions, with *Pediastrum*, *Hydrodictyon*, and *Sciadium*. In its earliest condition it consists of a free-swimming

* Ann. Jard. Bot. Buitenzorg, x. (1891) pp. 1-66 (6 pls.).

† Bot. Mag. (Tokyo), v. (1891) pp. 187-9 (1 pl.).

‡ Journ. de Bot. (Morot), v. (1891) pp. 288-90. Cf. this Journal, 1890, p. 490.

§ Flora, xlix. (1891) pp. 445-59 (2 pls.).

cœnobe of from ten to sixteen lanceolate cells attached to one another in a radiate manner, similar in structure to those of *Characium*. The development of these from the globular thick-walled warty resting-spores has not been observed. The cells do not contain a distinct chromatophore. From these colonies of lanceolate cells are developed either a second generation of similar colonies at their apices, somewhat in the same manner as in *Sciadium*, or a colony of spherical resting-spores which ends the series; or even a third generation of lanceolate cells may be produced in the same way. This is the vegetative mode of propagation. But there is also in all probability a mode of sexual reproduction similar to that in *Hydrodictyon* and *Pediastrum*. Within the lanceolate cells are formed gonids; and, though the escape of these has not been actually observed, they are motile, apparently biciliate, and probably conjugate in pairs. Under certain conditions the lanceolate cells of the first generation gradually pass into a spherical form, which appears to be a resting condition.

Chlamydomonas and Corbierea.*—Referring to Goroschankin's monograph of *Chlamydomonas*, M. P. A. Dangeard reaffirms the generic distinction between that genus and *Corbierea*,† dependent on the different position of the chromatophore. Goroschankin's *Chlamydomonas Kuteinikowi* he refers to the latter genus.

Glœotœnium.‡—Herr S. Stockmayer describes in detail this rare genus of Algæ. The mature family is 2-4-celled and round, elliptic or kidney-shaped on a surface-view. The 2-celled families have an envelope which passes over more or less into jelly. The cells themselves have a thick double membrane; the special character of the genus is a calcareous girdle which passes round the family at its broadest diameter, and has a black appearance, from its stronger refrangibility than that of the inclosing envelope. The form of the chromatophore is not stellate as described by Hansgirg, but bowl-shaped, agreeing with that in *Pleurococcus*, *Palmella*, *Palmophyllum*, *Glœocystis*, *Tetraspora*, and *Nephrocytium*. On this and other grounds the author dissents from Hansgirg's location of the genus, along with *Spirotœnia*, &c., as a member of a family Pseudodesmidiaceæ intermediate between Desmidiaceæ and Palmellaceæ; and regards its nearest allies as *Oocystis* and *Nephrocytium*, with which it may form the family Nephrocystiæ.

Fungi.

Parasitism of Fungi.§—Sig. F. Cavaia confirms the observation of Prillieux and Delacroix that certain fungi usually saprophytic may become parasitic under certain conditions. This was observed in the case of the ubiquitous *Botrytis vulgaris*, which grows on young branches of *Citrus*, as well as on *Dahlia* and *Pelargonium*; while *Tulipa Gesneriana* is attacked by an undescribed species which he names *B. parasitica*. He has also noticed the parasitism of *Cladosporium herbarum* on the raspberry, on *Cycas revoluta*, and on *Fourcroya*

* Le Botaniste (Dangeard), ii. (1891) pp. 272-4. Cf. this Journal, 1891, p. 631.

† Cf. this Journal, 1890, p. 489.

‡ Verhandl. K. K. Zool.-bot. Gesell. Wien, xli. (1891) pp. 21-6 (7 figs.). Cf. this Journal, 1890, p. 752.

§ Rev. Mycol., xiii. (1891) pp. 177-80.

gigantea. An instance is noted of *Polyporus ulmarius*, not usually described as parasitic, attaining a gigantic size, and causing evident pathological effects, on an elm-tree.

Parasites on Algæ.*—M. P. A. Dangcard describes the following fungi parasitic on various algæ:—

Olpidium aggregatum sp. n. on a marine *Cladophora*, allied to *O. Bryopsidis*.

Chytridium mamillatum, on *Draparnaldia glomerata*; *C. asymmetricum* sp. n. on *Conferva bombycina*; *C. (Rhizidium) sphærocarpum* on a *Zygnema*.

Micromyces Zygonii on a *Zygonium*. This is referred to the Synchytriæ.

Bacillus Closterii sp. n., on several *Closteria*.

A number of parasites on algæ are also described belonging to the animal kingdom.

Fungus-vegetation on Snow.†—M. Woronin finds that in Finland the snow is often covered, when it begins to melt in the spring, with fungus-mycele, derived largely from the excreta of animals, and developing into a *Mucor*. Where the snow has more completely disappeared, a different mycele is found, which develops into small sclerotes resembling those of *Penicillium*. This takes place even when the temperature falls every day below the freezing-point.

Sphærella gossypina sp. n.‡—Prof. G. F. Atkinson claims to have discovered the perfect stage of *Cercospora gossypina*, a very destructive parasite on the cotton-plant, in a *Sphærella* which he finds on both sides of the leaves of the same plant.

Dimorphism of *Hypocrea tuberiformis*.§—Prof. G. F. Atkinson describes the two forms of this fungus parasitic on *Arundinaria*,—the sphacelia stage found in May, and the ascigerous stage in August and September. The author claims to have established the affinity of the genus with *Epichloe*, the only difference being that in the latter genus the stroma entirely surrounds the stem of the host; while in *Hypocrella* (in which *Hypocrea* should be sunk) the mature stroma only partially surrounds the stem or is borne on the under-side of the leaf or leaf-sheath.

Conidiferous Apparatus of *Meliola*.||—M. A. Gaillard states that the conidiferous mycele of *Meliola* draws its origin from the same spore as the peritheciiferous mycele. The conids arise on simple ramifications of the conidiferous mycele or on simple or compound conidiferous threads. The denomination conidiferous threads ought to be reserved for those which issue from the conidiferous mycele; the threads of the peritheciiferous mycele never produce conids, and are sterile branches of this mycele.

* Le Botaniste (Dangeard), ii. (1891) pp. 231-68 (4 pls.).

† Arb. St. Petersb. Naturf.-Ver. (Bot.), xx. p. 31. See Bot. Centralbl., xlvii. (1891) p. 302.

‡ Bull. Torrey Bot. Club, xviii. (1891) pp. 300-1 (1 pl.).

§ Bot. Gazette, xvi. (1891) pp. 282-5 (1 pl.).

|| Rev. Mycol., xiii. (1891) pp. 174-7.

New Genera of Fungi.*—M. A. Giard describes the following new genera and species of entomophthorous fungi—*Epichlæa divisa*, on the body of an Ephemeron; it is composed of short cylindrical cells, bearing one or two spores at each of their extremities; *Halisaria gracilis*, on larvæ of a Dipteran; it is formed of slender slightly branched filaments, bearing greatly elongated ovoid-cylindrical spores at their extremity. A fungus, previously described as *Metarhizium*, found on the larvæ of *Liparis chrysorhea*, he now names *Chromostylium chrysorheæ*.

Sigg. Berlese and Bresadola† separate the genus *Morinia* from *Pestalozzia* by its muriform spores. They consider that *Langloisia spinosa* g. et sp. n., described by Ellis and Everhart, hardly differs from *Monosporium* or *Monilia*.

Fungus-parasites on *Acridium peregrinum*.‡—MM. J. Künckel d'Herculais and C. Langlois identify the fungus parasitic on this locust as nearly allied to *Polyrhizum Leptophyei* Giard. They state, however, that with this, as with other *Acridia*, the parasitism is entirely superficial and not morbid; and that death is caused, in most cases, by the attacks of a parasitic dipteran, *Sarcophaga clathrata*.

M. L. Trabant§ enumerates the various fungi which are parasitic on *Acridium peregrinum*, viz. (1) *Botrytis acridiorum* Trab. (*Lachnidium acridiorum* Giard); (2) *Cladosporium herbarum* var.; (3) *Saccharomyces? parasitaris*, found among the spores of the *Lachnidium*; (4) *Oospora ovorum* sp. n., a Hyphomycete which forms a white efflorescence, and produces groups of 20–30 long chaplets of spores. It does not appear to have any injurious effect on the development of the locust.

Parasite of the Cockchafer-larva.¶—M. A. Giard identifies the fungus parasitic on the larva of the cockchafer as *Isaria densa*, and asserts that the silkworm can be inoculated with it; it does not, however, readily produce spores on this host, but passes over into the sclerote condition.

M. Le Mout† describes further experiments in the cultivation of this fungus on artificial media, and reasserts its specific distinction from *Botrytis bassiana*, parasitic on the silkworm.

New Genera of Lichens.**—Herr J. Müller describes 37 new species of lichens found on the leaves of flowering plants or of ferns, and establishes from them eight new genera. *Calenia* is separated from *Lecania*, and *Tapellaria* from *Patellaria*, by the wide-meshed structure of the thalamium, and *Asterothyrium* from *Patellaria* by the stellate mode of opening of the disc. The five remaining new genera are characterized by the common characteristic of a *Phyllactidium*-like

* Bull. Sci. France et Belgique, 1889, p. 197 (5 pls.). See Bonnier's Rev. Gén. de Bot., iii. (1891) p. 285.

† Ann. Soc. Alpines Tridintini, 1889, 104 pp. See Bonnier's Rev. Gén. de Bot., iii. (1891) p. 287.

‡ Comptes Rendus, cxii. (1891) pp. 1465–8. Cf. this Journal, 1891, p. 636.

§ Rev. Gén. de Bot. (Bonnier), iii. (1891) pp. 401–5 (1 pl.).

¶ Comptes Rendus, cxii. (1891) pp. 269–72. Cf. this Journal, 1891, p. 636.

¶ Tom. cit., pp. 272–4.

** 'Lichenes epiphylli novi,' 8vo, 22 pp., Genf, 1890. See Bot. Centralbl., 1891, Beih., p. 334.

gonidema, the rows of cells which constitute it radiating and branching from a centre and forming a disc. By this character *Arthoniopsis* is separated from *Arthonia*, *Chroodiscus* from *Ocellularia*, *Rotula* from *Platygrapha* and *Opegrapha*, *Opegraphella* from *Opegrapha*, and *Phylloporina* from *Porina*.

Rev. F. R. M. Wilson * describes a number of lichens collected in the colony of Victoria, including a large number of new species belonging to a great variety of genera, and one new genus *Neophyllis*, belonging to the *Bæomycei*, of which, however, no generic diagnosis is given. A new species of *Myriangium* is described, *M. dolichosporum*, growing on the leaves of *Hymenanthera Banksii*.

Structure of Cladonia.†—Herr G. Krabbe has undertaken a careful examination of the structure of this genus of Lichens, for the purpose of clearing up some doubtful points in its morphology. Of the three parts of which the lichen is composed, the protothallus, the “podetia,” and the apothecies and “spermogones,” he shows that the “podetia” are not a part of the thallus, but of the organs of fructification; their morphology is described in detail.

The thallus consists of the three zones, the medullary, the gonidial, and the cortical layers, of which the last is continually dying off from above, and renewing itself by the growth of fresh filaments from the gonidial layer; during this process algal cells are carried into the cortical layer, where however they perish, in consequence of the cortex being closed on all sides against the atmosphere. The thallus appears always to be developed out of sorcides. It is in a definite zone of the gonidial layer that the ascogenous hyphæ are formed, arising usually from sterile filaments, and becoming gradually differentiated in the course of their growth. Their number in a fructification varies greatly, but they are always alike. They usually break through the cortical layer in the form of a small tuft. The “podetia” become hollow, and the ascogenous hyphæ are ultimately ruptured from the place of their formation, and grow into the hymenium, which is formed at the apex of the fructification out of vegetative filaments; they develop at their apices into sacs. Various modifications of the mode of formation of the fructification in the different species of *Cladonia* are described, and the following classification proposed:—

I. Species with homosporous fructification and simple “podetia”; no formation of funnels; branching very slight, differentiation early (*C. cæspiticia*, *cariosa*, *bacillaris*, &c.).

II. Fructification simple, or more or less branched; heterosporous (*C. endiviæfolia*, *squamata*, &c.).

III. Fructification much branched; either heterosporous or homosporous; differentiation late (*C. pyxidata*, *rangiferina*, &c.).

Besides the ascogenous fructifications, *Cladonia* produces also conidial fructification (“spermogones”). They are formed in the thallus, and develop, by long-continued apical growth of the hyphæ, to fructifications closely resembling the ascogenous, the development of the

* Journ. Linn. Soc. (Bot.), xxviii. (1891) pp. 353–74 (1 pl.).

† ‘Entwicklungsgesch. u. Morph. d. *Cladonia*,’ 4to, viii. and 160 pp. and 12 pls. Leipzig, 1891. See Bot. Centralbl., xlvii. (1891) p. 302.

conidiiferous resembling that of the ascogenous filaments; the conidiiferous "podetia" are also an element of the fructification, and not of the thallus. From a phylogenetic point of view the author regards the homosporous as an earlier, the heterosporous forms as a later development.

In the earlier stages the fungal hyphæ receive their nutriment entirely from the algal gonids; as the thallus gradually dies off from below, the gonids are replaced, in their nutritive function, by soredes, formed out of special assemblages of hyphæ, and out of thallus-scales borne on the "podetia"; and these are essential to the later nutrition of the fertile shoot, the growth of which may extend over a century.

Laboulbeniaceæ.*—Mr. R. Thaxter gives a list of the American species belonging to this order of Fungi, in which a large number of new species are described, and the following new genera:—

Cantharomyces. Receptacle simple, or compound above the supra-basal cell, from which one or more divisions may arise, each bearing a solitary perithece; pseudo-paraphyses one or more, arising from the supra-basal cell; perithece median, tapering towards its symmetrical apex.

Peyritschella. Receptacle composed of two superposed basal cells, above which it is multicellular, one cell on the inner side forming a short sharp projection. Perithece one, sometimes two, when single terminal, nearly median, subconical, the spreading apex symmetrically four-lobed; pseudo-paraphyses arising from several different points on either side of the receptacle.

Zodiomyces. Main body of the fungus tapering to a narrow base of attachment, parenchymatously multicellular, the distal end eup-shaped, with a more or less well-marked rim, within which arise, from the central parenchyme, stalked peritheces and simple septate sterile filaments. Peritheces asymmetrical, the apex bent to one side, appendaged, borne on simple septate pedicels having a rounded prominence just below the perithece. Spores hyaline, fusiform, asymmetrically once-septate, involved in mucus.

Hesperomyces. Perithece asymmetrical, thrice transversely constricted, with an abruptly conical appendiculate apex, borne on two cells, one of which is prolonged downwards to form a pedicellate connection with the receptacle. Receptacle of three cells, one basal and two distal; from the outer of which arises the antheridial appendage; from the inner (as a bud) the stalked perithece. Antheridial appendage simple, cylindrical, septate, with a single lateral row of tooth-like projections.

Saccharomyces kefir.†—Mr. C. L. Mix describes a yeast found in the United States and Canada, apparently identical with the milk-fermenting kephir of the Caucasus and other parts of Eastern Europe. It occurs in the form of small granules of a dirty brown colour, which retain their vitality for a long period, and consist of a small proportion of yeast-cells imbedded in zooglœa masses of rod-shaped bacteria. The yeast-

* Proc. Amer. Acad. Arts and Sci., xxv. (1890) pp. 5-14, 261-70.

† Op. cit., xxvi. (1891) pp. 102-14. Cf. this Journal, 1889, p. 99.

cells are elliptical or spherical, the latter averaging $4.2\ \mu$ in diameter, the former varying from 10.5 to $6.5\ \mu$ by 6 to $4\ \mu$. They increase by budding; no formation of spores could be detected. They do not invert cane-sugar like ordinary beer-yeast. They cause alcoholic fermentation in milk-sugar or lactose, and in dextrose, but not in cane-sugar or saccharose. The bacteria are short cylindrical rods with homogeneous protoplasm, varying from 8.5 to $4.5\ \mu$ in length by $0.8\ \mu$ in breadth; by cultivation they develop into leptothrix-threads in which spores appear. They appear to take no part in the fermentation, remaining almost wholly in the zooglœa masses during the process.

Red-coloured must-fermenting Yeast.*—Herr C. Kramer isolated by Hansen's method, from the sediment formed during the fermentation of wine-must, a representative of the pink yeasts. Its cultivations were further examined in dextrose-gelatin. In 48 hours punctiform whitish colonies appeared, and these in about fourteen days became reddish. The cells of the yeast were usually round or oval, the vast majority having a diameter of 2.7 – $3.5\ \mu$. Very large individual elements were also noticed; these varied in breadth from 1.5 – $2.5\ \mu$ broad and 6 – $10\ \mu$ long. Combinations of more than three cells were rare. On solid media the colonies were apparently united into little masses by a gelatinous excretion easily soluble in water. Each cell is invested in a pretty strong membrane, and contains a round highly refracting body, giving with alcohol, ether, and osmic acid all the characteristic reactions of fat.

From the absence of spore-formation (cultivation for a long time on gypsum blocks at 20°C.) the fungus showed that it was not a true blastomycete of the genus *Saccharomyces*.

The red pigment, which only occurs on old cultivations, is easily soluble in water, but vanishes at once on addition of acid or alkali.

In dextrose solution this pink yeast excites a lively alcoholic fermentation, and it seemingly belongs to the upper yeasts. The formation of alcohol by the yeast is quite considerable, for after eight days' fermentation at 25° , 4.5 vols. per cent. could be demonstrated in 10 per cent. dextrose solution, the solution acquiring an agreeable must odour.

In acid solutions the fermentation is more lively than in alkaline, an addition of 1.5 per cent. tartaric acid acting rather favourably than inhibitory on the fermentation and development of the fungus. With regard to the behaviour of the fungus to other kinds of sugar, it was ascertained that saccharose was inverted before fermentation, that maltose was fermented directly, and lactose not at all.

Musk Fungus from Tree-sap.†—Prof. F. Ludwig has found on lime-trees a mucoid flux, which runs down the trees, having a dirty white or yellowish appearance and a gelatinous or cartilaginous consistence. On microscopical examination it was found that the predominating organisms were a fungus resembling *Leptothrix* and a *Fusarium*. After being cultivated on pepton-gelatin the *Fusarium* exhaled in about two days the

* Oesterr. Landwirthsch. Centralbl., i. (1891) pp. 30–45. See Centralbl. f. Bakteriöl. u. Parasitenk., x. (1891) pp. 124–5.

† Centralbl. f. Bakteriöl. u. Parasitenk., x. (1891) p. 214. Cf. this Journal, 1891, p. 784.

penetrating odour of musk. This particular Mycomycete, with tetrapartite crescent spores, found on the mucous flux of limes and beeches, possibly also of other trees, is identified as being the *Fusisporium moschatum* Kitasato, and is therefore the same organism as the *Fusarium aqueductum* Lagerh.

Black-rot of America.*—M. P. Viala describes in detail the development of this disease of the vine, and discusses the various modes of treatment proposed. He states that its correct name is *Læstadia Bidwellii* Viol. et Rav.

Sig. U. Martelli † describes the spread of this disease in the vineyards of Italy.

New Egg-plant disease.‡—Under the name *Phoma Solani* sp. n., Prof. B. D. Halsted describes a fungus causing a new disease, which is very destructive to egg-plants (*Solanum esculentum*) while still growing in the hot-bed, and causing the condition known as damping-off.

New Parasitic Fungus on Wheat.§—Herr G. Lopriore describes the destruction caused in wheat-grains and in seedlings by the attacks of *Dematium pullulans*. It has not previously been observed as a pathogenic parasite on wheat, and the author believes it to be the cause of various hitherto unexplained diseases.

Pachyma.||—After giving a full account of the structure known under this name, M. E. Fischer states that he agrees with M. Prillieux in his view of its nature, and concludes by stating that *Pachyma* ought to be considered as the sclerote of a hymenomycetous fungus.

New Genera of Fungi.¶—Mr. G. Massee describes two new genera of Fungi:—*Sarcomyces*, nearly allied to *Hæmatomyxa*, but distinguished by a flat sharply margined hymenium, and by the muriform spores arranged in a single row in the cylindrical ascus; and *Dacryopsis*, in which he places several species separated from *Tremella*, *Coryne*, and *Ditiola*.

Actinomyces.**—Dr. C. E. Barnard gives details of the prevalence of actinomycosis in cattle in Tasmania and in the other Australian colonies, and of the transmissibility of the parasitic fungus which causes the disease, *Actinomyces*, from the lower animals to the human subject.

Lowly-organized Fungi.††—M. E. de Wildeman describes the deformation produced in filaments of *Zygogonium* by the attacks of *Micromyces Zygogonii*, which he regards as allied to *Synchytrium*. He also describes a *Chromatium* allied to *C. Weissii*, and gives the reactions of the colouring matter with a variety of reagents.

* Ann. de l'école nat. d'agriculture de Montpellier, iv. pp. 308-43. See Bot. Centralbl., xlviii. (1891) p. 151.

† Nuov. Giorn. Bot. Ital., xxiii. (1891) pp. 604-10.

‡ Bull. Torrey Bot. Club, xviii. (1891) pp. 302-3.

§ Landwirthsch. Presse, 1891. See Bot. Centralbl., xlviii. (1891) p. 192.

|| Rev. Mycol., xiii. (1891) pp. 157-60. Cf. this Journal, 1891, p. 507.

¶ Journ. of Mycology, vi. (1891) pp. 178-84 (1 pl.). See Bot. Centralbl., xlviii. (1891) p. 142.

** Papers Roy. Soc. Tasmania, 1890 (1891), pp. 254-9.

†† C.R. Soc. Roy. Bot. Belgique, 1891, pp. 169-77 (2 figs.).

Rabenhorst's Cryptogamic Flora of Germany (Fungi).—Parts 34–36 of this publication continue the treatment of the Pezizaceæ with the completion of the Calicieæ (*Calicium* and *Stenocybe*). The last subdivision of the Patellariaceæ, viz. the Arthoniæ, comprises the genera *Phacopsis*, *Conida*, *Celidium*, *Lecidopsis*, *Arthonia*, and *Arthothelium*. The next family is the Bulgariaceæ, divided into the Callorieæ (*Agyrium*, *Orbilis*, *Calloria*, and *Staminaria*), and the Bulgaricæ (*Ombrophila*, *Paryphydria*, *Coryne*, *Bulgaria*, and *Sarcosoma*). The 5th sub-order, Pezizæ, comprises the Mollisieæ, Helotieæ, Eupezizeæ, and Ascoboleæ. The Mollisieæ are again divided into the Eumollisieæ (*Mollisia*, *Niptera*, *Belonidium*, *Belonopsis*, *Tapezia*, and *Trichobelonium*), and the Pyrenopezizeæ.

Parts 45, 46 commence a monograph of the Phycomycetes by Dr. A. Fischer. They are divided into three series, the Archimycetes or Chytridinæ, the Zygomycetes, and the Oomycetes. The Chytridinæ are again divided into Myxochytridinæ and Mycochytridinæ, and the former of these into Monolpidiaceæ or Olpidiaceæ and Merolpidiaceæ or Synchytriaceæ. After a general discussion of the structure of the Chytridinæ, a full account is given of the genera belonging to the first family, viz. *Sphærita*, *Olpidium*, *Pseudolpidium* gen. n., *Olpidiopsis*, *Pleotrachelus*, *Ectrogella*, and *Pleolpidium* gen. n. *Pseudolpidium* consists of species separated from *Olpidium* and *Olpidiopsis*; *Pleolpidium* of species separated from *Rozella*. Under the Merolpidiaceæ a full account is given of the genera *Synchytrium*, *Woronina*, *Rhizomyxa*, and *Rozella*. The Monochytridinæ are divided into Holochytriaceæ or Ancylistaceæ (*Myzocyttium*, *Achlyogeton*, *Lagenidium*, *Ancylistes*), Sporochytriaceæ, *Rhizopidium*, *Rhizidium*, *Rhizidiomyces*, *Achlyella*, *Septocarpus*, *Entophlyctis* gen. n., *Rhizophlyctis* gen. n., *Obelidium*, *Chytridium*, *Polyphagus*), and Hyphochytriaceæ (*Cladochytrium*, *Amæbochytrium*, *Catenaria*, *Hyphochytrium*). The two new genera are separated from *Rhizidium*.

Mycetozoa.

New Myxomycetes.*—Dr. G. A. Rex establishes a new genus of Myxomycetes, *Dianema*, with the following characters:—Sporanges simple or plasmodiocarpous, with membranous non-calcareous walls; capillitium composed of threads without characteristic thickenings, running entirely across the sporange, attached both to the base and to the opposite wall, and not joined together to form a network. He regards the genus as the single representative of a new and separate family, adjoining the Perichæaceæ in the order Calonemææ.

The following new species are also described—*Dianema Harveyi*, *Physarum nucleatum*, *P. penetrans*, *Chondrioderma aculeatum*, *Stemonitis Weberi*, *S. virginicensis*, *S. nigrescens*, *Comatricha irregularis*, *Cribbraria violacea*, *C. lanquescens*, *Trichia Andersoni*, *Hemiarcyria obscura*, *H. longifila*, *H. Varneyi*, all gathered in N. America.

The author further describes the capillitium of *Hemiarcyria clavata*, as seen with a homogenous immersion-lens, differing somewhat from the structure as previously described.

* Proc. Acad. Nat. Sci. Philadelphia, 1891, pp. 389–98, 407–8.

Protophyta.

a. Schizophyceæ.

Cell-contents of the Phycchromaceæ.*—In opposition to the observation of Zacharias, Herr V. Deiniga finds, in the species of Phycchromaceæ (Cyanophyceæ) examined—viz. *Oscillaria princeps* and *Frölichii*, *Aphanizomenon flos-aquæ*, and *Nostoc* sp.—true chromatophores having the form of a more or less perforated plate in contact with the cell-wall. He states also that the cell-nucleus is of a different nature in Algæ (e. g. *Spirogyra*) from that in the higher plants. In *Aphanizomenon* and *Nostoc* the chromatophore is coarsely reticulate.

Both these statements are controverted by Herr E. Zacharias,† who asserts that the bodies observed by Deiniga can have nothing to do with true chromatophores. For the examination of the cell-walls, and of the process of cell-division in the Cyanophyceæ, he strongly recommends Gomont's process, of treating with 50 per cent. solution of chromic acid, washing, and staining with methyl-blue. Both the cell-walls and the contents are thus coloured; the imperfect walls in the cells in process of division can be detected, the cell-contents having receded from them. Within the cell are the greatly diminished and constricted protoplasmic cell-contents.

Structure of Diatoms.‡—Mr. E. M. Nelson describes some new high power diatom resolutions. Among them are the following:—*Coscinodiscus apiculatus*, consisting of a crown of small perforations round the primary, and of still smaller perforations within the primary; these latter are so fine that they are difficult to observe. *Systephania diadema*; in the comparatively coarse primaries there arises a zone, and they are connected by delicate walls of silex, which are above the hexagonal structure, and which pass at right-angles over it. A fragment of a *Coscinodiscus*, consisting of an isolated secondary structure which has broken out of the primary areolations. *Pleurosigma angulatum* with postage-stamp fracture. A *Navicula*, with a fine pipe running through the centre of the raphe which opens to the exterior at the extremity of the valve, and which then passes down the valve to the central nodule. From the central nodule there is a fine tube leading to the interior of the valve. These tubes occur also in kindred species.

New Diatoms.§—M. J. Brun publishes, in 12 plates, 120 microphotographs of new species or varieties of diatoms. They have been prepared from apochromatics, and the beautiful drawings have been made with the camera lucida, according to the method pursued in Schmidt's Atlas.

Möller's Plates of Diatoms.—Herr J. D. Möller's Atlas of "Lichtdrucktafeln Möllerschen Diatomaceen-Präparate" consists of 59 beautiful folio photographic plates of diatoms. The first ten plates each contain impressions of a very large number of species arranged

* Bull. Soc. Imp. Nat. Moscou, 1891, No. 2, 28 pp. (1 pl.). Cf. this Journal, 1890, p. 371.

† Bot. Ztg., xlix. (1891) pp. 664-7.

‡ Journ. Quekett Micr. Club, iv. (1891) pp. 315-9 (1 pl.).

§ Mém. Soc. Phys. et Hist. Nat. Genève, xxxi. (1891) (12 pls.). See Bot. Centralbl., xlviii. (1891) p. 170.

systematically. In the remainder, except the last, marine, fresh-water, and fossil species are photographed belonging to special geographical areas, the Baltic, the Mediterranean, New Zealand, Japan, Mexico, Barbadoes, Brazil, Hungary, Bolivia, &c., or from diatomaceous earths or deposits. Plate 59 is a "show-plate" of some of the more beautiful diatoms arranged in patterns.

B. Schizomycetes.

Chemical and Physiological Researches on the Secretions of Microbes.*—MM. A. Arnaud and A. Charrin describe the elimination of the carbon and nitrogen in the transformation of asparagin under the influence of *Bacillus pyocyaneus*. In a culture of the bacillus containing 1.6 grm. of asparagin, after fifteen days 1.16 grm., or 72.5 per cent., was eliminated as CO₂, and .221 mgrm., or 13.8 per cent., was found to be present in the protoplasm of the microbe. In the case of the culture of the bacillus in a gelatin solution, the nitrogen eliminated as ammonia was found to be 70 per cent., while in a culture of asparagin 91 per cent. was found to have been eliminated.

Osmotic Experiments on Living Bacteria.†—M. A. Wladimiroff gives the details of experiments undertaken with living bacteria and various salt solutions. The method adopted was to examine the movements of the bacteria in a drop of salt solution and meat broth hanging from the cover-glass of a suitable microscopic slide, and to observe at what concentration there remained a few bacteria which retained the ability to swim slowly, and in what slightly stronger solution the last swimming bacterium had vanished. A table giving the "limiting solution" which is the mean of these concentrations for six bacteria, and ten salts, is appended to the paper.

New Comma Bacillus.‡—Dr. T. Smith isolated from the large intestine of swine a comma bacillus which differs from those usually described in not liquefying gelatin. Cultivations were successfully made in gelatin and agar, wherein superficial and deep colonies appeared, the former being flat and circular and attaining a diameter of 3-5 mm., while the latter were more spheroidal or raspberry shaped with an averaged diameter of 0.5 mm. The organisms also grew well in neutral pepton bouillon and in hanging drops. Lively movements were visible. The predominating form was that of a comma, but there were also spirilla of one and a half to two, and occasionally of ten turns. This vibrio was found to be strictly aerobic, and to possess no fermentative action on sugar. Milk remained unchanged. On potatoes a thin yellowish encrustment appeared in a few days. The flagella were easily stained by Loeffler's method, though an addition of acid to the ferrotannate solution was unnecessary. The vibrio did not appear to have any pathogenic action.

Fish-poisoning.§—Dr. M. Arustamoff describes a series of eleven cases of fish-poisoning which occurred under his observation at Astrakhan.

* Comptes Rendus, cxii. (1891) pp. 1157-60. Cf. this Journal, 1890, p. 83.

† Zeit. Physikal. Chem., vii pp. 529-43. See Journ. Chem. Soc., 1891, Abstr., p. 1131.

‡ Centralbl. f. Bakteriöl. u. Parasitenk., x. (1891) pp. 179-80.

§ Tom. cit., pp. 113-9.

The fish, which were raw salmon and salted sturgeon and sterlet, were apparently eaten in these instances uncooked. The most prominent symptoms were weakness, general pains, and a paralytic condition of the secreting organs, e.g. dryness of the mucosas, suppression of urine, obstinate constipation, also dimness of vision and abnormal temperature. The post-mortem appearances were not noteworthy, but microscopical and bacteriological examination resulted in demonstrating the same microbes as were found to infest the fish. Four micro-organisms are mentioned as having been isolated from the sterlet and salmon, those from the latter liquefying gelatin, while those from the former form a dry greyish-white crust on the surface. By both sets of microbes bouillon is rendered turbid, and they slowly deposit themselves at the bottom of the tube. The cultivations are without odour. The sterlet microbes are about $3/4 \mu$ thick and $1\frac{1}{2}$ – 2μ long, those of the salmon being a little thicker and longer. Both sorts were frequently observed in pairs, were only faintly stained by anilin pigments, and were decolorized by Gram's method.

Rabbits injected subcutaneously with pure cultivations died more or less quickly, but cats and dogs similarly treated recovered in a few days after passing through a pretty severe attack of poisoning.

Spore-formation in Anthrax Bacilli.*—In making some observations relative to spore-formation in anthrax, Dr. R. Turró cultivated bacilli and spores on the surface of a 3 per cent. agar-meat-broth; and under these conditions he found that the colonies developed better, and that spore-formation occurred much earlier, than when the ordinary method was adopted. It was also remarked that under these circumstances the sporulation began at the uppermost layers, gradually descending to the deeper layers until the whole consisted almost of a mass of spores. As the spores were found both at the end and in the middle, it was inferred that their development was directly connected with their free exposure to the air, an inference supported by cultivating some anthrax under a cover-glass; for here the spore-formation was seen to be free enough round about the edge, while it was scanty at the centre.

But though there seems to be direct connection between sporulation and the presence of air, the bacilli only form spores when exposed to the action of oxygen, if the nutrient medium has been rendered unfertile from the diffusion therein of the decomposition-products of the bacillary growth; and it is this view that the author accepts rather than that spore-formation is due to the exhaustion of the cultivation medium.

Schizomycetes in the Gall-bladder.†—Dr. Naunyn examined bacteriologically the contents of the gall-bladder in three cases of gall-stone. In two of these the fluid obtained was sterile, while from the third was obtained a bacillus which had certain resemblances in common both with *Bacterium coli commune* Escherich and with Fried-

* Gaceta Medica Catalana, 1891, Nos. 3–4. See Centralbl. f. Bakteriöl. u. Parasitenk., x. (1891) pp. 91–2.

† Deutsche Med. Wochenschr., 1891, No. 5. See Centralbl. f. Bakteriöl. u. Parasitenk., x. (1891) pp. 92–3.

laender's diplobacillus. On microscopical examination this microbe was found to be a short thick mobile rodlet, usually arranged as a diplobacillus, but occasionally in chains of 4-6 links. It grows at ordinary temperatures on the usual cultivation media, and very quickly at 37°. It does not liquefy gelatin, and is a facultative anaerobe. It is pathogenic to animals (dogs). The occurrence of this micro-organism is interesting, since two or three other observers have described a quite similar bacillus inhabiting the gall-bladder.

Metabolism of *Bacillus fluorescens liquefaciens*.*—This bacillus, says Dr. Hoffer, is a small thin rodlet, which, as its name implies, liquefies gelatin, while round about the margin of the liquefied portion of the medium a greenish-yellow fluorescence shortly appears.

The bacillus was cultivated in peptonized bouillon for about four weeks at the ordinary temperature. The bouillon was then treated by Brieger and Fraenkel's method, in order to determine if any toxalbumin were present. No toxalbumin was found, but the process revealed the existence of some other metabolic products, for example, ammonia, precipitated with platinum chloride; kreatinin, easily detected by Jaffé's reaction; and a peculiar proteid obtained in the following manner. The concentrated bouillon was precipitated with ten times its volume of absolute alcohol, and after frequent purification a yellow powder was obtained. As this contained a considerable quantity of ash, it was further purified until a whitish-grey powder resulted. This body, which is very soluble in water, gave the characteristic biuret reaction with sulphate of copper and caustic soda. From this and other considerations it is probably not a pepton, and its most prominent peculiarity is that if only a trace be dissolved in water and then any alkali be added, a green fluorescence exactly like that seen in pure cultivations of the *Bacillus fluorescens liquefaciens* appears.

The condition under which this fluorescence takes place is alkalinity, and in the case in question this is explained by the production of ammonia.

Moreover, when all the gelatin is liquefied and the bacilli form a whitish sediment, the fluorescence gradually dies away, but may be partially revived by the addition of a few drops of ammonia to the cultivation.

Immunity to the *Vibrio Metschnikovi*.†—M. Gamaleïa, who had already made out that the animals which enjoyed a natural immunity to the *Vibrio Metschnikovi* were also resistant to the toxin, has recently endeavoured to fathom this refractory condition. In the urine of rabbits which had been injected with large quantities of sterilized vibrio-cultivation, the vibriotoxin could not be demonstrated. Hence it would seem that this property of rendering the bacterial poison harmless resides in the tissues of the refractory animals, and does not take place, as in sensitive animals, by being excreted in the urine. If the toxic fluid be rubbed up with the spleen of a living rabbit and the mixture kept at the body temperature, it loses all its poisonous properties in two to four hours, but

* S.B. Phys.-Med. Gesell. Würzburg, 1891, pp. 35-8.

† Le Bulletin Méd., 1890, p. 1108. See Centralbl. f. Bakteriöl. u. Parasitenk., x. (1891) p. 133.

the reverse is the case if the temperature be raised to 60°–80°, the other conditions remaining the same.

Rabbit's blood-serum, too, possesses an antitoxic property, but in a weaker degree than the spleen.

Immunity to Anthrax.*—Dr. G. Gabritschewsky records some experiments made with the view, first, of finding if it were possible to render animals immune by repeated inoculation with greatly diluted virulent anthrax cultivations; and, secondly, whether the blood and juices of animals which had been made artificially immune could impart immunity to animals sensitive to anthrax.

In the first series four sets of experiments are recorded, in which dilutions of the cultivations 1:20, 1:200, 1:500, 1:10,000, were injected. It was calculated that in 0.19 ccm. of the last dilution there were from 2–10 bacilli. With but one exception all the animals died, and on the survivor the experiments are not yet concluded.

It is right to say that one rabbit which had lived through two injections succumbed to a third.

This method, which has proved successful in symptomatic anthrax, swine erysipelas, and *Diplococcus pneumoniae*, fails with anthrax.

The second series is interesting because, as is usual with experimental bacteriology, it is in direct opposition to a series of apparently quite conclusive experiments made by other bacteriologists, Ogata and Jasuhara, who maintained not only that they had discovered an antidote to anthrax and mouse septicæmia, but that they could isolate it from the blood. It was therefore a ferment, and a ferment that was capable of annihilating the bacteria of anthrax and of mouse septicæmia, and of preventing the development of cholera and typhoid bacilli.

The author having rendered two dogs and four rabbits immune, the latter by the method of Roux and Chamberland, and having extracted their blood and body-juices by pressure, injected some of these fluids into animals—rabbits, mice, and guinea-pigs—and these were thereupon inoculated with anthrax. On one occasion an animal thus treated lived about three hours longer than the control animal, but all the rest of the results were quite negative. The ill-success of the author gives him opportunity for suggesting that the Japanese dogs are possessed of more or of a different kind of immunity.

Bacteria in the Dairy.†—Prof. H. W. Conn deals first of all with the process of creaming and the separation of a coagulable substance analogous to the fibrin of blood which takes place a short time after milking. The author then passes on to the ripening of cream, which precedes the formation of butter, and which may be considered as a spontaneous fermentation imparting to butter its agreeable aromatic flavour.

According to Storch and Weigmann, this process is brought about by certain kinds of bacteria, and can therefore be artificially set up in pasteurized cream by means of pure cultivations.

From bacteriological investigations carried out to ascertain the part played by bacteria in this process, the author found that these were

* Centralbl. f. Bakteriöl. u. Parasitenk., x. (1891) pp. 151-7.

† Third Annual Report of the Storr's School Agricultural Experimental Station, 1891. See Centralbl. f. Bakteriöl. u. Parasitenk., x. (1891) pp. 252-3.

extremely numerous, and that in scarcely any two lots of cream from the same dairy were the kinds of bacteria alike, but that the acid-forming species invariably predominated.

Capsule Bacteria from Intestine of Swine.*—Dr. T. Smith, while examining bacteria from intestines of pigs, found colonies of capsule bacilli occasionally mixed up with those of *Bacillus coli*. Of these he isolated three, and compares them morphologically and biologically with Friedländer's capsule bacillus; the four organisms are distinguished by the letters *a*, *b*, *c*, *Fr*.

The bacteria *a*, *b*, *c*, are evidently closely allied, and are possibly to be regarded as sports of one species. Morphologically they are scarcely distinguishable from one another. All are motionless rodlets in which a capsule is frequently to be distinguished, and which do not liquefy gelatin. They are facultative anaerobes, ferment sugar with formation of CO_2 and H_2 , and coagulate milk. All form a ropy substance, which in the case of *b* is very copious, and makes milk viscid.

Besides the foregoing these bacteria present several minor differences. In the course of his remarks the author notes that drying often makes a colony become polymorphic, and that this may be prevented by dipping the plugs or corks of a tube or roll cultivation in sterile paraffin. It is also pointed out that the capsules of bacteria may be detected by placing a fragment of a quite fresh cultivation on a drop of water and examining it as a hanging drop. Then if the edge of the drop be focused on, it will be found that where the bacteria are packed closely together they are everywhere at the same distance apart, and in many cases, by careful focusing, the capsule can be distinctly seen.

Results of Bacteriological Examination of Liège Water.†—M. E. Malvoz says that, when estimating the properties of a drinking water, it is not sufficient merely to determine whether the water can at the time be used without danger, but to diagnose whether it is likely to suffer from contamination in the future. The presence or absence of pathogenic micro-organisms, the total number of germs, and the quantity of organic matter have to be determined. A certain amount of the latter points, even in the absence of micro-organisms, to a possible infection of the water, and if it contain no pathogenic microbes and no suspicious organic matter, yet the number of saprophytic bacteria are to be taken into consideration in calculating whether a water be well protected against impurities, since the latter may at times be succeeded by pathogenic micro-organisms. If the quantity of germs vary from time to time, it may be laid down that there exists a permanent source of contamination, but liable to oscillations.

Infection of the Fœtus through the Placenta.‡—In his experiments for ascertaining the path by which pathogenic bacteria pass from the mother to the fœtus, Dr. Birch-Hirschfeld used anthrax bacilli, and paid special attention to the microscopical appearances of the placenta.

* Centralbl. f. Bakteriöl. u. Parasitenk., x. (1891) pp. 180-6.

† Ann. Soc. Méd.-Chir. de Liège, 1890, Nos. 8, 9. See Centralbl. f. Bakteriöl. u. Parasitenk., x. (1891) pp. 197-8.

‡ Ziegler's Beiträge zur Path. Anat. u. Allgem. Pathol., ix. No. 3. See Centralbl. f. Bakteriöl. u. Parasitenk., x. (1891) pp. 85-8.

The animals inoculated while pregnant were dogs, rabbits, goats, and mice, and the sections were as a rule made so as to pass through wall of uterus, placenta, and fetal membranes.

Ten animals were inoculated, and in half the number of instances the virus passed from mother to offspring. Considerable differences were detected in the various animals in the spread of the bacilli in the fœtus, yet their intra-vascular position was everywhere clearly visible. Of all the organs the liver was most affected, and seemed to form a centre for the further dissemination of the bacilli.

The conditions which influence the transference of the bacilli to the fœtus seem to be numerous, such as unequal susceptibility, duration of the disease, dissimilarity of the structure in the placentas, differences in quality and quantity of inoculated virus, and also in the position selected for inoculation.

The author seems disposed to regard the healthy placenta as a fairly effective barrier or filter against minute foreign bodies, such as micro-organisms, but admits that the placenta is penetrable by pathogenic microbes, an admission which seems quite countenanced by the result of his own experiments, for he shows that in 50 per cent. of the cases transmission of the living virus took place.

Passage of Anthrax from Mother to Fœtus.*—In the first series of experiments made by Dr. Latis, fifteen guinea-pigs were inoculated at various periods of gestation. It was found that in eight out of the fifteen cases a transference of the virus from the mother to the fœtus had certainly taken place. The bacilli were always found in the maternal blood four to five hours before death, but in only two of the eight successful experiments were the bacilli found in the umbilical vein. Hæmorrhages were never observed in the placenta. In certain places accumulations of bacilli were found in small blood-vessels, occasionally they were seen lying transversely in the wall of the vessel, and also between the cells of the decidua. It was supposed that the anthrax bacilli escaped from the vessels by diapedesis, and experiments to ascertain this were made on the mesentery of ten guinea-pigs inoculated with anthrax. The blood was examined from time to time during life, and the mesentery after death, the animals having been killed at various periods of infection. The author derived the impression that if there were only very few bacilli in the blood, no vascular changes ensue; if there were many, that a moderate number of leucocytes and a few red corpuscles emigrated from the vessels, and that this emigration became more marked as the severity of the infection increased.

In the last stages, not only leucocytes and red corpuscles are found outside the vessels, but bacilli also. Rupture of the walls of the vessels was never perceived.

Hence the author concludes, from a consideration of the phenomena observed in the mesentery under the placenta, that when the anthrax virus passes from mother to fœtus, the transference is effected by diapedesis, and occurs after some change has taken place in the wall of the vessels.

* Ziegler's Beiträge zur Pathol. Anat. u. Allgem. Pathol., x. p. 148. See Centralbl. f. Bakteriöl. u. Parasitenk., x. (1891) pp. 225-6.

Resistance of Bacteria of Swine Erysipelas to boiling, stewing, frying, salting, pickling, and smoking.*—From the experiments made by Dr. R. J. Petri with bacteria of swine erysipelas, it seems that, though bouillon cultivations are destroyed in fifteen minutes at 52°, the destruction of the organisms is not effected with certainty when a piece of swine's flesh is boiled, stewed, or fried. Boiling, however, was successful provided the pieces were not heavier than one kilo and the boiling was kept up for about two and a half hours. There was some evidence that anaerobic cultivations were able to withstand a somewhat higher temperature.

Pickling was equally unsatisfactory; for virulent cultivations on silk threads soaked in 14 per cent. salt solution, to which 0·7 per cent. sugar and 0·4 per cent. saltpetre had been added, for a period of twenty days; were not destroyed; but by using a brine containing 23·5 per cent. of salt the bacteria were killed, a diminution in their virulence being noticed on the eleventh day; and from the experiments altogether, it appears that pickled pork is quite as dangerous as fresh.

The results of salting (16 gm. of saltpetre to the pound of salt) hams and flitches of bacon were, that after thirty days the meat was found to contain as many bacteria as before, and that thirteen out of eighteen mice inoculated from it died of the disease. The following result, which affords an interesting commentary on the difference between artificial and natural experiments, is worth noting. In default of any flesh of an animal dead of swine erysipelas, recourse was had to injecting healthy meat with virulent bouillon cultivations, not only in great quantity but at various depths. In twenty-eight days all the bacilli were dead.

Two hams and flitches which had been salted for thirty days were then smoked for fourteen days. At the end of this time, eleven out of eighteen mice inoculated with pieces taken from the bacon died; but by allowing these hams and flitches to hang, it was found that after 167 days the bacilli could not be detected, hence it takes about half a year by this procedure to render swine's flesh free from the disease.

In what way the disease is set up is at present very uncertain, for the feeding experiments were practically all failures.

Chemical Bacteriology of Sewage.†—Sir H. E. Roscoe and Mr. J. Lunt publish an abstract of their contributions to the chemical bacteriology of sewage. With regard to all the organisms which they describe, the authors have determined the absorptive power for free oxygen when cultivated in a perfectly pure state, and they have determined for which of them free oxygen is a necessity. They are able to show that anaerobic organisms associated with putrefaction, although able to grow in complete absence of oxygen, are able to absorb that gas rapidly, when it is present, and thus to prepare the conditions for their anaerobic growth. Some of them are incapable of liquefying gelatin without the presence of oxygen. Both in the case of aerobic and anaerobic organisms a very appreciable diminution of the liquefying

* Arbeiten a. d. Kaiserl. Gesundheitsamte, vi. p. 266. See Centralbl. f. Bakteriöl. u. Parasitenk., x. (1891) pp. 135-7.

† Proc. Roy. Soc. Lond., xlix. (1891) pp. 455-7.

power of organisms takes place, after repeated sub-cultivation in nutrient gelatin.

Fermentation of *Bacillus coli communis*.*—Dr. V. Seruel reports that this bacillus is developed, in solutions containing glucose, as well when the supply of air is shut off as when there is an uninterrupted supply of it. However, in the latter case spores are more abundantly formed, and the decomposition of the sugar is more complete. The difference may be explained as due to the accumulation of carbonic acid. Acids formed in fermentation are not derived from one another, but arise independently. Acetic and lactic acids are probably residual formations, and as they are not attacked to any extent, they accumulate in the cultivations. Formic acid is, in all probability, produced in much greater quantities than one would suppose from the analysis; it is decomposed in proportion to its production, and furnishes hydrogen and carbonic acid. The proportional relation between acetic and lactic acids is the same, whether the cultures are aerated or not; and as the relation of these acids to the sugar consumed is also independent of conditions of aeration, we may suppose that the destruction of glucose obeys the same laws in the presence as in the absence of oxygen.

Products of *Staphylococcus pyogenes*.† — MM. A. Rodet and J. Courmont find that certain pathogenic microbes are able to form simultaneously in the culture-medium distinct vaccinating and predisposing substances. *Staphylococcus pyogenes* is an example of this. The vaccinating substance formed by this microbe is precipitated by alcohol, while the predisposing substance is dissolved. In filtered cultivations the effect of the vaccinating substance is completely masked by that of the predisposing substance; heating for twenty-four hours at 55° is sufficient to make it appear.

Destruction of Amœboid Cells by Micro-organisms.‡ — From experiments made on animals Dr. A. Ruffer concludes that the wandering cells of the lymphoid tissues of the alimentary canal have the power of wandering to the free surface of such tissues, and of taking into their interior micro-organisms and foreign matter (charcoal, &c.). There are two kinds of wandering cells in the lymphoid tissues of the alimentary canal, *a*, microphages (small mono- or multi-nucleated cells); *b*, macrophages (large mono-nucleated cells). The macrophages are developed from the small mono-nucleated lymphocytes. Macrophages are able to swallow microphages (leucocytes) and to destroy and digest them. Micro-organisms are rapidly destroyed in the interior of the micro- and macrophages. Micro-organisms are never found lying free between the cells or in the blood-vessels and lymphatics. The destruction of micro-organisms taking place in the normal lymphoid tissues of the alimentary tract resembles, in all particulars, the destructive process following on the inoculation of pathogenic micro-organisms into resistant animals.

It is further noted that the epithelioid cells of other lymphoid organs

* La Cellule, vii. (1891) pp. 179-202.

† Comptes Rendus, cxiii. (1891) pp. 432-5.

‡ Brit. Med. Journ., ii. (1890) pp. 491-3.

and of pathological new formations possess the same power of amœboid movement, for example those of the spleen, the lung, and of lymphatic glands.

The epithelioid cells of the infective granulomata have similar functions; thus in tubercle these cells not only take in and digest the bacilli, but also the smaller cells which enter into the formation of the tubercle nodule.

From a similar point of view the large multinucleated or giant cell is regarded. It is a fighting cell in fact. With regard to quarter-evil the conclusions are that the inflammatory process resulting from the infection is a protective one, the destruction of the micro-organisms being carried out entirely by the amœboid cells present in the inflammatory exudation.

With regard to diphtheria it is stated that the diphtheritic bacilli are present in the most superficial parts of the membrane only, and that the only reason why the bacilli do not penetrate into the tissues is that they are arrested by the amœboid cells present in the diphtheritic membrane.

Microbes of the Mouth.*—M. Th. David has recently brought out a work in which he deals, in a very thorough manner, with micro-organisms infesting the mouth. The book is well got up and excellently illustrated. In the general part the form, staining, and cultivation of micro-organisms are first discussed, after which those which inhabit the mouth, and from there may pass into the organism, exciting local or general disturbances.

In the general portion the first chapter is devoted to the making of staining solutions, the preparation of nutrient media, of plates, &c. In the second chapter the more important saprophytes are described and discussed, while the third is devoted to pathogenic micro-organisms met with in sputum, bacillus of sputum septicæmia, *Pneumococcus*, Friedländer's bacillus, *Streptococcus pyogenes*, *Staphylococcus pyogenes aureus* and *albus*. Chapter iv. deals with the microbes provoking diseases of the mouth and teeth, after which follow practical and therapeutic measures for the preservation of teeth—indeed we understand that this work is intended for the special behoof of those interested in dental work; but this of course does not in any way detract from its merits, which are signalized by M. Pasteur in a laudatory preface.

Action of Anilin Dyes on the Development and Virulence of Microbes.†—MM. Eraud and Hugounenq have recently examined the behaviour of various anilin pigments towards anthrax, *Staphylococcus pyogenes aureus*, and *Gonococcus*; and from their experiments they conclude that, of the dyes examined, methylen-blue and safranin in very dilute (2 per cent.) solutions do not damage the growth so much as the virulence of the micro-organisms referred to, but that in more concentrated solutions, or after more prolonged action of the dilute, the growth also suffers.

* Paris, 1890, 302 pp., 113 figs. See Centralbl. f. Bakteriöl. u. Parasitenk., x. (1891) p. 609.

† Lyon Méd., 1891, No. 14. See Centralbl. f. Bakteriöl. u. Parasitenk., x. (1891) p. 615.

Putrefactive Bacteria.*—Putrefactive decomposition is directly due to certain bacteria, and indirectly to moisture, warmth, and air. Post-mortem decomposition is, says Dr. S. Trombetta, mainly the result of the emigration of bacteria from the intestinal canal to the blood, organs, and tissues. That these micro-organisms are not present in the blood or organs during life has been demonstrated by several observers; and the author's experiments had in view the determination of the time when these micro-organisms begin to invade the body, or in other words, how long after death the body generally remains free from micro-organisms.

It was necessary to be pretty sure that the animals used in the experiments were healthy. They were then killed by blows on the head, and their bodies kept for a certain time either in incubators at the ordinary temperature or in a refrigerator. Agar cultivations were then made from the blood and organs, and the results of these cultivations are recorded in a series of tables. The animals used were mice, rats, and rabbits.

It was found that there existed a time limit below which the blood and organs of an animal killed while in a healthy condition are free from decomposition bacteria; that this period was increased by refrigeration and diminished by incubation; that the decomposition varied with the age of the animal, but not in proportion thereto; that the decomposition process appeared irregularly in the blood and organs; and that the process was not affected by the kind of animal used.

The following table shows the time when decomposition bacteria appeared, at low, medium, and high temperatures.

	Medium Temperature.	Low Temperature.	High Temperature.
	hours	hours	hours
Mice	19	22	5
Rats	18	20	5
Rabbits.. .. .	16	20	6

Toxin Fever of *Bacillus pyocyaneus*.†—The injection of Koch's lymph, says M. A. Charrin, is followed by phenomena known as the reaction, the principal factor being rise of temperature, and this occurs not only in tuberculous, but in leprous, syphilitic, and healthy persons. The author records how the toxin of *Bacillus pyocyaneus*, injected for hæmostatic purposes, invariably produced a rise of temperature, provided that the dose were sufficient in quantity.

It seems that the subcutaneous injection of 3 ccm. provokes considerable fever, but a dose of from 1 to 2 ccm. is not followed by a rise of temperature of any importance.

Isolating *Bacillus* of Typhoid from Water.‡—M. H. Vincent recommends the following method for obtaining pure cultivations of typhoid bacillus. To a test-tube of bouillon is added 1 drop of a 5 per

* Centralbl. f. Bakteriöl. u. Parasitenk., x. (1891) pp. 664-9.

† Comptes Rendus, cxiii. (1891) pp. 559-60.

‡ C.R. Soc. Biol., 1890, No. 5. See Centralbl. f. Bakteriöl. u. Parasitenk., viii. (1890) pp. 212-3.

cent. solution of carbolic acid to 2 ccm. bouillon, and then 5-15 drops of the water to be examined; the tube is then covered with a rubber cap and kept at a temperature of 42°. As soon as the bouillon becomes cloudy (8-12 hours) a fresh inoculation in pure bouillon is made from this cultivation. This second cultivation will usually be found sufficient to get rid of other bacteria, leaving a pure cultivation of immobile short diplo-bacilli. If the second cultivation be still impure, then a third or fourth may be tried.

In endeavouring to isolate the bacillus of typhoid from water by passing it through three series of cultivations in carbolized bouillon, he finds* that this procedure allows another microbe, *Bacterium coli commune*, to develop. Consequently a mixed cultivation may result, giving on potato a prominent yellow cultivation instead of a moist colourless track, indicative of the simple presence of the typhoid bacillus. It is necessary, therefore, to make a plate-cultivation from the carbolized bouillon, in order to separate the bacillus of Eberth from its satellite, *Bacterium coli commune*.

Holst's Bacteriology for Students and Practitioners.†—From the fact that this work on bacteriology has been translated from the original Norwegian into German, and seems to have been well received, it would appear that the aim of the author, which is to deal with bacteriology from a practical and non-scientific point of view, has been fulfilled. To state the facts of bacteriology in a way to be easily grasped by the student and easily applied by the struggling practitioner, is a most desirable intention, and one which deserves proper recognition if successful. The get-up of the book is on a par with its contents.

Pocket-book for Students of Bacteriology.‡—The second edition of Dr. H. Bernheim's pocket manual of bacteriological formulæ, useful alike to commencing and advanced students, has been enlarged. The present edition contains the Soyka-Král method of making permanent cultivation preparations.

Diagrams for Bacteriological Lectures.§—Dr. C. J. Eberth is now publishing a series of diagrams intended for lectures on bacteriology.

The diagrams, of which three have already appeared (1, *Streptococcus pyogenes*; 2, Cholera bacillus; 3, Tubercle bacilli), are coloured plastic representations on a white ground of the micro-organisms copied from actual specimens.

The plates are mounted on canvas, and the magnifications vary from 20,000 to 60,000, so that the configurations of the bacteria are easily visible at a distance of 10-12 yards.

* Annales de Micrographie, ii. (1890) pp. 432-3.

† Basel, 1891. See Centralbl. f. Bakteriöl. u. Parasitenk., x. (1891) pp. 219-20.

‡ Würzburg, 1891. See Centralbl. f. Bakteriöl. u. Parasitenk., x. (1891) p. 234.

§ Berlin, 1891. See Centralbl. f. Bakteriöl. u. Parasitenk., x. (1891) pp. 251-2.



MICROSCOPY

a. Instruments, Accessories, &c.*

(1) Stands.

The Binocular Microscope of the Seventeenth Century.†—Mr. Charles E. West writes:—"It is generally understood, I believe, that the binocular Microscope is a modern invention—that it goes no further back than the one made, about 1853, by Prof. J. L. Riddell, of the University of Louisiana. His instrument was a rude affair, made of two pieces of looking-glass, which was improved by Prof. A. K. Eaton, of this city, by substituting for the mirrors a solid prism of glass made of two triangular prisms which were cemented together. Riddell adopted the improvement. This is the basis of the modern binocular Microscope. Its perfection depends upon the equal division of the beam of light by the prism, or the nearness of that division into halves, so that the same amount of light may traverse each of the tubes to the eyes.

I never used but one instrument that did this, and that was made by J. Zentmayer, of Philadelphia. I tried it on the *P. angulatum* with the 1/5, 1/10, 1/15, 1/30, and 1/40 objectives, which resolved the frustule as satisfactorily as with a monocular. I have never found another binocular of this maker that would do this, and I have tried several.

But the first inventor of the binocular seems to have been Antonius Maria de Rheita, a Bohemian Capuchin, mathematician and astronomer, who published a work in 1645, under the title of 'Oculus Enoch et Eliæ, sive Radius Siderio Mysticus,' a rare book, which I found in the Astor Library of New York.

By a contemporary writer, R. P. F. Ioannes Zahn, who published an optical treatise in 1685, entitled 'Oculus Artificialis Teledioptricus, sive Telescopium,' there is given a minute description of de Rheita's binocular Microscope and telescope. This work is in my possession, and from it I hope to prove that the binocular Microscope is no new thing.

In a letter to his friend, J. Caramuelis, dated Cologne, 24th April, 1643, de Rheita speaks of having detected most clearly, by means of his binocular telescope, 'with the greatest surprise, admiration, and delight, the sacred Sudarium Veronicæ sive faciem Domini maxima similitudine in astris expressum,' in the sign of Leo, between the equinoctial and zodiacal circles. Zahn has given in his work a figure of our Lord's head as pictured on the handkerchief of St. Veronica. George F. Chambers, in his revision of Admiral Smyth's 'Cycle of Celestial Objects,' has given a reproduction of the figure, and characterized it a 'pious fraud,' A.D. 1643.

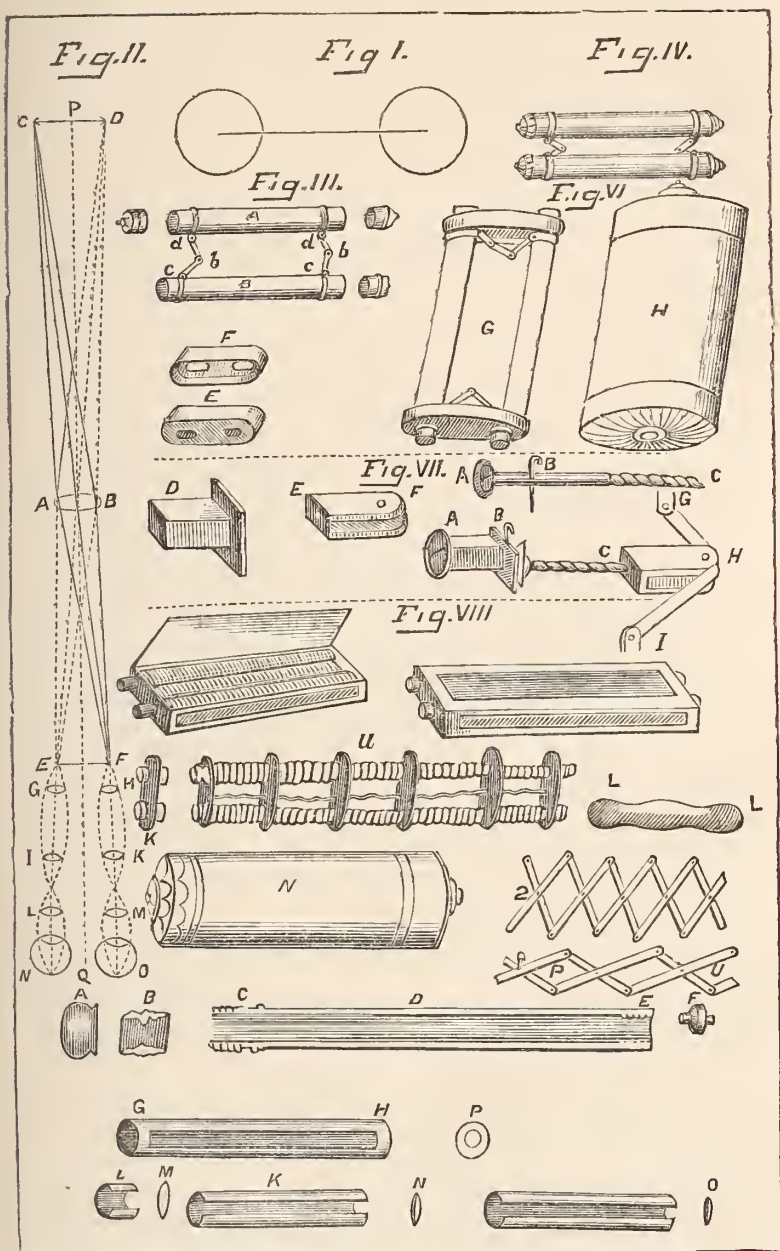
I propose to give a translation from the Latin of such parts of the 'Oculus' as have a bearing upon the binocular Microscope, as follows:—

'Since the distance between the eyes is not the same for all persons, first of all an artificer must ascertain this distance if he wishes to construct a tube perfectly fitting any one person. This can be best ascer-

* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

† Proc. Amer. Soc. Micr., xii. (1891) pp. 57-66.

FIG. 3.



tained (as elsewhere has been shown and as de Rheita also has said) by the aid of a pair of compasses and a mirror. This distance serves for adjusting the first ocular lenses, since in the binocular tube the two other lenses nearest the eye must be similarly placed to each other—e. g. if the centres of the pupils of any person be distant AB , 22, 100 ped. Rom. (fig. 3. I.), at this distance also from each other must the other first lenses be, ab and cd , as is shown by the figure, so that the centres of the lenses ab and cd should meet at the points A and B .*

‘Let us suppose one simple tube be constructed with a convex ocular lens of very great aperture, which shall be greater than the distance of the two eyes, *generally speaking* it will be impossible, by using one convex ocular lens, however large, for an image radiating from the tube to affect both eyes alike, for if the image radiating from the tube through one lens could affect both eyes alike, both eyes must be at the point of contact; but this is impossible, since both eyes cannot be at the same point at the same time, and thus all parts and points of the image cannot be transmitted to the same parts and points of both eyes at once. I have said *generally speaking*, because if one look at a mirror of very obtuse convexity and at a great distance from the eyes, perhaps something can be effected: but it is of little practical use, for the objective lens must be of extremely long diameter to represent the object sufficiently large and near, so the tube would be obliged to be of enormous length.

‘III. A binocular tube can be constructed with one objective lens when the image thrown from the objective lens can extend itself to a sufficient distance in the base of the divergence and thence again radiate through ocular lenses to both eyes. Thus the object CPD (fig. II.) radiating through the objective lens AB , forms the image EF ; but the rays of the image, digressing from E , reach the eye N through the ocular lenses GIL , and from F reach the eye O through the lenses HKM . Thus a binocular tube can be constructed with one objective lens AB ; but by this method the rays from the object reach the eye after being greatly refracted and diverging very far from the axis PQ of the objective lens, so that the image is never clear and distinct. Moreover, both eyes cannot see the whole of one object, nor is the same part of the object seen by both eyes, though more of the object can be seen by moving it about, but it will always be confused. Hence a tube thus constructed is never of much use.

‘IV. Even if one large lens be taken having two apertures at exactly the proper distance apart, and both eyes look through these apertures at a single object, and thus see one and the same thing (which, however, seems impossible), nevertheless a perfect binocular tube cannot be formed, because, just as the radiation from the object comes to both eyes by rays remote from the axis, and hence more refracted, so will the image possessed in the eye be indistinct and confused.

‘V. The best construction of the binocular tube is made by two telescopes exactly alike, so fitted to both eyes that the optical axis passes through one and the same object (figs. III., IV., VI., VII. VIII.). The

* The plate is reduced one-half from pencil tracings. The letters on fig. I. were accidentally omitted. AB are the ends of the straight line, ab , bc the diameters of the circles on the same line prolonged. The circles represent the eye-lenses to be just as far apart as the observer's eyes.

two objective lenses must be exactly alike; not only of the same shape, but also alike in magnifying power and in point of clearness. (The same care must be taken, whether the lenses be concave or convex.) Again, the telescopes must have the same "ordinate," so that not only the objective lines, but also the eyes similarly placed will correspond precisely to each other; but the telescopes and their first ocular lenses must be as far apart as is the distance between the centres of the pupils of the two eyes. The telescopes should be so directed toward one and the same object as if there were but one aperture for both tubes, and through this aperture the object, brought wonderfully near, can be very distinctly seen.

'VI. Since there are various kinds of telescopes, the ordinary Galilean, made of convexo-concave lenses, others convexo-convex, which can be made from pure convex lenses, and, indeed, again, out of these others can be so formed that they present objects inverted, as it is said to be the case with astronomical telescopes. Others present the object erect, but whether straight or curving inwards depends on the nature of the ordinate. The former can be made from four convex lenses, the latter from a plane glass and two very powerful lenses, &c. Thus also various binocular tubes can be made, depending on the ordinates of the telescope, provided that the ordinates be the same for the same binocular tube, taking the distance of the first ocular lens and the direction of both ordinates through one aperture, so to speak, so that the same object will be seen single and not double.

'VII. For lesser binocular tubes common telescopes not exceeding a foot in length are best, because those more than a foot long do not present the object completely enough. The smaller the telescopes the greater the object. Tubes of this kind are made with three lenses for each telescope, having their ordinates placed as indicated in No. 13, cap. 5, *seq.* The proportion of the lines there indicated is also much approved.

'VIII. How to join the two telescopes. The two tubes may be made of copper or brass plates, as in fig. III., where two tubes A and B are joined by brass hinges at *abc*; then, where the tubes are placed, both eyes are accommodated to any remote object, and the object will appear single and with great clearness. How the tubes may be joined, placed, closed, and covered is shown in fig. IV. Likewise several movable rods similarly connected could be placed in each tube, but this method has disadvantages. Two tubes with their lenses arranged so as to be adapted to any vision are best constructed by cases or capsules as follows:—Make a capsule of brass leaf in the form of an ellipse, as shown in H (fig. VI.). Make two apertures in the lesser capsules E and F as far apart as the distance between the eyes. These apertures must also be elliptical, as E and F in the figure. The size of the apertures should be such that the tubes or rods A and B, also C and D, would perfectly correspond.

'The two discs E and F of both tubes must be so firmly fastened that the tubes will not slide up and down too easily. Thus we now have all things arranged as in the figure G. This entire affair can be put into the greater capsule H and there encased. Thus it can be easily and safely carried about. The capsule H may be of wood, leather, or other material, and decorated to suit the taste.

'IX. Since the distance between the two eyes does not differ much

for many individuals, and also since the eyes easily accommodate themselves, many artificers fit their own eyes and fasten the rods in the tubes firmly in one position, so that they cannot be moved. I have made many such myself. Although they fit most people well enough, yet some eyes are unpleasantly affected after looking steadily for a long time. Least of all must such tubes be used for magnifying, unless they be adjusted to the distance between the eyes, since they harm the eyes not a little, and when used too much may even turn the eyes from their natural position (cross-eyed), as I have known happened to a certain nobleman. Thus it is always better to make the rods movable, so that they can be fitted to all eyes; yet it is allowable to make a little common binocular tube with movable rods, to be placed in a case after the manner of a little book, thus: Make a small capsule the size of the tubes which it is to contain, cover this with leather, and put on clasps just like a little book. Put two thin wooden tablets at the ends where the ocular bands and objectives meet, but where the clasps are opened. These must be shoved aside, so that the eyes can look through the tubes. The cases may be so constructed that the open space between the two tubes can hold the "ignitabulum" with its sulphur thread (match-box) and the burning-glass for quickly making a fire in the field or anywhere you please. Above this space a cover of thin brass is placed, on which is fixed a magnetic needle. At the other end, which is covered with leather where the book closes, can be placed a movable circle to point to the moon, according to the hour of the night; and thus various other things can be added.

'X. The long rods holding the lenses can be of various materials and shapes, but it is best to be so made that the lenses can be cleaned when necessary, for they will become dusty, no matter how carefully they are closed. That part of the tubes just before and just behind each ocular or objective lens should be so arranged that a small linen cloth could be inserted through an aperture for the purpose of wiping the lens.

'XI. In convexo-convex binocular tubes it is better for the first ocular lenses to be quite acute, so that the eyes can be placed nearer the same objects. They should always be a little more acute at the bottom than in simple convexo-convex tubes, since there is a greater clearness from the two eyes looking at the same thing. I have found these to be good proportions:—The objective lenses remove the focus to a distance of $1\frac{1}{2}$ ft.; the middle ocular lens, equally convex on each side, has a diameter $35/100$ Rom. ft.; the first ocular lenses anywhere from a diameter $20/100$. This is also a good binocular tube. Objective lenses remove the focus to a distance of 2 ft.; middle lenses, equally convex, $40/100$ diameter; first lenses, near the eye, $20/100$ and $25/100$ diameter. Another good tube, objective lenses at a focus of 4 ft. Middle lenses, equally convex on all sides, $50/100$ diameter. First ocular lenses, unequally convex, from diameter $30/100$ and $35/100$.

'XII. Two convexo-convex telescopes inclosed in a case can be made adjustable to any vision in the following manner:—Join the two telescopes by movable arms (as indicated in No. 8 of this chapter), and through these arms place a spiral screw, which can lengthen or shorten the telescope at will. This is shown in the 7th figure. ABC is a nail cylindrically round from A to B, spirally round from B to C. At B is a small nail, by which the large nail ABC is kept in place after being

placed through the round aperture D. Thus the arms G H and I H, joining the two telescopes, can be contracted or extended. The form E F is placed upon H, and both arms G H I are held in place by a small nail passing through F and H. There the spiral part B C is placed through E. Now, if the head A of the nail A B C be turned this way or that, the arms G H and I H, joining the two telescopes, will be contracted or lengthened.

‘XIII. Cases to contain long binocular tubes should be made of strong solid wood and the tubes within so firmly made that they cannot bend; also that the glasses may at any time be taken out and the tubes differently placed, so as to be adapted to one vision or another. The upper part of the case must be so fitted with clasps that it can be closed or opened at pleasure. Long tubes of this kind can be made square like oblong beams, and may be made of plates of alloy of silver, lead, and iron, joined in several pieces, which can be easily separated from each other again. I saw a tube of this kind constructed by P. Rheita. It was at the Castle of Herbiopolensis.

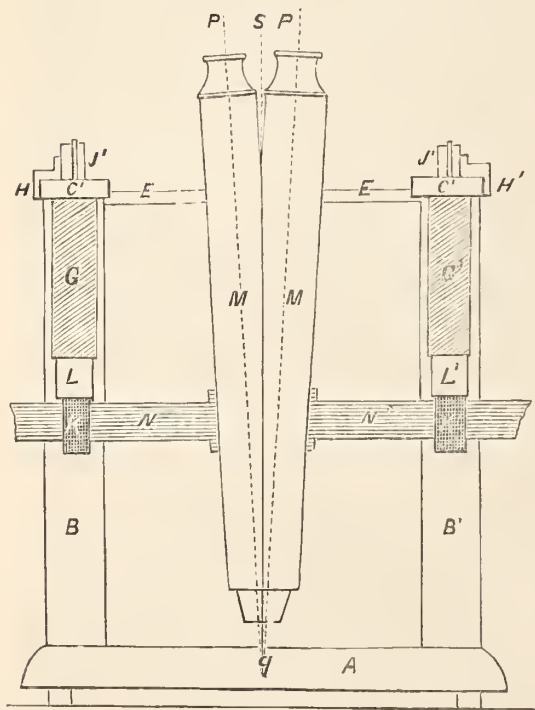
‘XIV. The longer the binocular the better, but the less convenient. How the inconvenience may be remedied I will show. Where these tubes are to be used they may be placed on long poles and easily extended or contracted. Tubes of this kind are very useful in war for viewing the enemy from afar, &c. I have selected the construction of a tube of this kind which I have heard P. Rheita used in his wonderful binocular telescope, whose lenses were not fitted to tubes, but to a certain capsule which could be folded like a pair of bellows. The length of this was about ten hands when extended on a pole. They say that it made the moon of enormous size, which can easily be believed. The manner of constructing this kind of binocular tube is as follows:—In the first place, make tubes out of leather folded like paper lanterns, or like the leather pipes used by hunters and bird-catchers for alluring beasts and birds. Crumpled leather tubes of this kind can be fitted to transverse plates, in which are placed the glasses, as in A B C D E F, fig. VIII. These plates vary in number according to the length of the tube and hold the tubes perfectly straight, and also (since they have holds within) transmit to the eye a clear image, as is the case commonly in other telescopes. The transverse tablet is shown in G H in the figure. Again, that access may be had to the ocular glasses, some part of the transverse plate B and C can protrude on either side (as is seen in J K), to which are attached the leather tubes after the manner of a capsule. When the tubes are to be attached to the pole for use, cords or little chains *a b c d e* are put through all the transverse tablets, and at each of these tablets a knot is made, or in some other way the exact length of the desired extension is kept. Then nails at *a* and *f* fasten the tube to the pole and hold it at the desired extension. It can be constructed as in M and inclosed in the capsule N (for it must not be kept stretched on the pole all the time), and thus conveniently carried about. Instead of a pole, a contrivance like that shown in V P can be used, which can be extended to any length and again folded together, as in fig. 2, and easily carried about; also one large leather tube holding both telescopes can be made, which can be extended at pleasure like a pair of bellows. Many of the contrivances might be mentioned for showing the object right side up in astronomical binocular tubes, &c.’

Binocular Microscope.—Take for the objective glass a lens equally convex on all sides, of a diameter $80/100$. The principal focus will be at a distance $40/100$. Now remove the object a little beyond this distance, so that the rays behind the objective lens can converge to form an image. This image will be much larger than the object (as we have shown in formula 2), for at double the distance it will be equal to the object itself, and from double the distance till you reach the focus it (the image) will always be larger, till at the focus there will be no image at all, because there the rays behind the lens are parallel. The object placed beyond double the distance of the focus always makes the image less and less than the object, till it is placed at so great a distance that rays falling upon the lens are considered parallel and the image is found in the distance of the principal focus. All this has been already shown elsewhere. Behind this greater image two other ocular lenses are placed. One near the image itself is exceedingly convex on all sides, of a diameter $25/100$. This arrangement shows the object very large

and a little farther away than in ordinary composite Microscopes shown in cap. 2.

On account of lengthening the tube, or the greater distance of the lenses from each other (if a similar arrangement be made for both eyes), both eyes can easily look at one and the same object. The two '*prios*' lenses, ocular lenses, should be as far apart as is the distance between the two eyes, and all else arranged as in binocular tubes already explained. Such a Microscope in its external form may be like the one shown in the figure, where A B is the case. Within are the two tubes, arranged as we have already shown in treating of binoculars. The object to be looked at is placed at C."

FIG. 4.

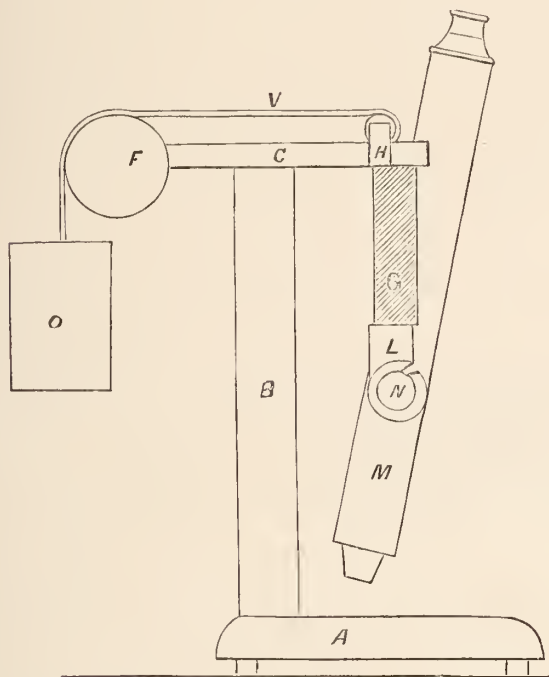


*Binocular Perimicroscope.**—This instrument, devised by Aubert, is practically Westien's binocular lens with much increased magnifying

* Pflüger's Archiv, xlvii. (1890) pp. 341 6 (2 figs.).

power. As the accompanying figures (4 and 5) show, the instrument consists of a double tube, supported on a stand, consisting of a base-board A and two vertical pillars B B'. The objectives are so adapted that the lines of vision unite exactly on the object. The true field of vision has, with a magnification of 25 diameters, a diameter of 10 mm., the distance between the objective and the object being 40 mm. The double tubes alter their position in a vertical direction by means of the cylinders L,

FIG. 5.



which work in the tubes G, and they are balanced by the weight O. Horizontal and transverse movements are imparted through the cylinders N N', which are connected with the pieces K K'. Owing to this mobility, an object of 17×9.5 cm. = 161.5 qcm. can be examined, hence the name Perimicroscope. The instrument is adapted to the examiner's eyes, or rather, the distance between two pupils, by pulling out the oculars until a single image is seen. The instrument is focused with one hand, and owing to its mobility, obliquely lying surfaces can be examined. The object to be examined is placed on a black, white, or green glass plate placed on the stand A, which will, of course, receive a small vessel or any other object-holder.

Lantern Microscopy.*—The following correspondence has appeared on this subject:—"Permit me to say a few words in connection with

* English Mechanic, liv. (1891) pp. 309-10, 332.

Mr. Chadwick's paper on Leach's Lantern Microscope, reported in the issue of Nov. 13th.

In the first place, Mr. Chadwick is dead against every authority regarding magnification. Extreme magnification, such as Mr. Chadwick suggests, is condemned by every authority of note, both for the Microscope and for the lantern Microscope. That the magnification which enables the observer to see *all* the details of an object is the largest to which it should be subjected, anything beyond this defeating the purpose. Mr. Chadwick says that, with his arrangement, high powers can be used for class and other demonstrations, although he has previously stated that the arrangement of condensers is only adapted for objectives of $4/10$ in., which is by no means a high power. Mr. Chadwick cannot surely be ignorant of the fact that lantern Microscopes, of whatever make, have long been discarded by college authorities where *high* powers are required. I see, too, that he has come round to my views, and does not recommend the use of special objectives.

His last paragraph but two is a contradiction of the previous portion of his paper, where he leads us to suppose that he can use high powers—that is, of course, $1/15$ in. or $1/20$ in. objectives—with his arrangement, simply because he uses an alum-trough. What he says is simply this: in order to use a high power requiring a large amount of light, interpose an alum-trough which stops 50 per cent of the light. Mr. Chadwick does not seem to be aware of the fact that it is possible to focus the heat-rays at a point beyond the luminous rays, and thus avoid all heating of the slide. I should just like to inform Mr. Chadwick that the substage condenser of which he speaks, and the novel way of interchanging the objectives was used by me more than sixteen years ago, and shown to Mr. Leach in 1876.

In conclusion, Mr. Chadwick says that lantern Microscopes which have no alum-trough are self-condemned. This I deny, as I do not use an alum-trough and never will, and I may say that I have never melted a slide.—J. A. FURNIVEL."

"I am pleased to see Mr. Furnivel's plain and simple defence of himself on this subject. He may fairly be considered the father of the simple lantern Microscope, and as I have worked with both his simple form, without alum-trough and also with Leach's, I may say that experience fully bears out his statements. That it is possible with either form to get a large projection on the screen with a good lime-light is no doubt correct; but after a most careful testing of both under precisely the same conditions, I most certainly prefer Furnivel's at less than half the price. My object in testing both was to obtain a clear definition of the different yeast-cells on the screen, but after repeated trials, with the assistance of some experts with the lantern and Microscope, we failed totally with both, the best results being obtained with Furnivel's arrangement. With a Powell and Lealand $1/4$ in. apochromatic the results under the best conditions were most unsatisfactory, and we found with either form the highest power which could be used was a $4/10$.

It sounds very large indeed to talk about the proboscis of a blow-fly 16 ft. long; but the fact is that the same would be far better shown if only 3 ft., and would make a much more effective picture in any ordinary

room. I have no experience with the arc light in the micro-lantern, and therefore my remarks do not apply to this.—THOS. FLETCHER."

(2) Eye-pieces and Objectives.

Zeiss's New Microscope Objective.*—Count F. Castracane referred to the new Zeiss's objective of $1/10$ in. focal length and numerical aperture 1.63, and the beautiful photomicrograms of *Amphipleura pellucida* taken by Dr. Van Heurck to test its value. In these the square structure of the minutest grain is clearly visible. The magnification employed amounted, according to Van Heurck, to 2000 diameters, and consequently the longitudinal divisions would amount to 5000 to the mm., thus exceeding considerably the limit of visibility determined by Helmholtz's theory. As no mention was made of such a result by Prof. Abbe when he demonstrated the utility of an illuminating cone of wide aperture in connection with the new Zeiss objective, it seems possible that Van Heurck has made a mistake in assigning the magnification, especially when it is considered how little reliance can be placed upon the magnifications given by the makers of Microscopes.

(3) Illuminating and other Apparatus.

New Hot Stage.†—M. Drosten describes a new hot stage which will be found very serviceable in microscopy. It consists (fig. 6) of a shallow box made of glass plates soldered together by an enamel which is not affected by heat or liquids. In one of the side walls of the box a thermometer and two glass tubes *a* and *b* are fixed. The heating of the stage is effected by a stream of warm water, which enters by the tube *a* and passes out by tube *b*. By regulating the flow of water in *b* by means of a clamp a very constant temperature, only varying by half a degree, can be obtained. The stage, being entirely of glass, can be used with all objectives up to the highest magnification.

FIG. 6.

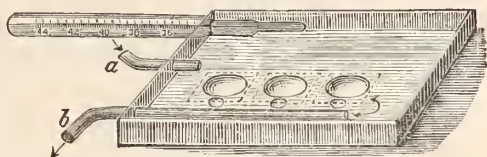
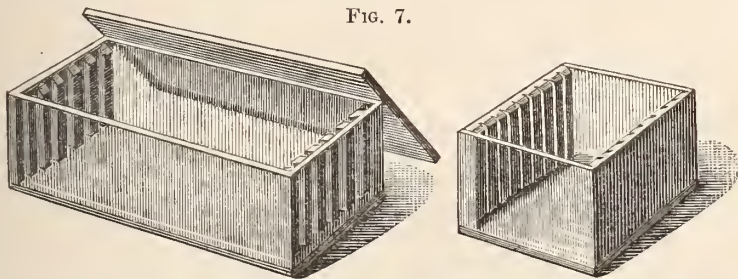


FIG. 7.



Glass Slide-boxes.‡—M. Drosten describes slide-boxes constructed of glass plates united by an enamel which is not dissolved by alcohol

* Atti Acc. Pontif. de' Nuovi Lincei, xliii. (1890) pp. 215-6.

† Bull. Soc. Belg. Micr., xviii. (1891) pp. 5-7.

‡ Ibid.

or any other liquid. The large model (fig. 7) is provided with grooves for the reception of slides of 76×26 mm., and the small model is intended for cover-glasses of 18 mm. in the side.

Arsonval's Thermostat modified for Benzin-heating.*—Mr. J. Ogmannikow has so modified Arsonval's gas thermostat that it can now be heated with a benzin lamp of special construction, for the details of which the original must be consulted.

The temperature maintained is said not to vary more than from $0^{\circ} \cdot 1$ – $0^{\circ} \cdot 4$ and usually not more than $0^{\circ} \cdot 2$. Where gas is not obtainable a device of this sort is very useful.

(4) Photomicrography.

Photomicrography.†—For photomicrographical work the two requisites are a Microscope and a camera. The Microscope must possess an arrangement which allows the body-tube to be brought into a horizontal position while the foot rests firmly upon the table. The camera differs from the ordinary portrait camera in the greater length to which it can be drawn out. Such apparatus have been supplied for years by very many firms; but they are either very expensive or, if cheap, are very defective, not possessing generally the length of bag which is indispensably necessary for taking bacteria, diatoms, &c. The institute of Klönne and Müller, of Berlin, has lately supplied a cheap and at the same time neatly constructed apparatus which answers every requirement. Dr. R. Neuhaus, an authority on photomicrographical work, describes this apparatus in his 'Anleitung zur Mikrophotographie.' The camera can be drawn out to 1·80 m., and as there is light-proof connection of this with the body-tube there is no direct contact of the two. Sunlight reflected from a heliostat is the most convenient source of light. As the best substitute for sunlight, Neuhaus proposes the electric arc light, while other authors regarding this as too unsteady, recommend the magnesium, or still better the zircon light. But petroleum light is sufficient for almost all purposes. The proper method of illumination is by means of the condensing system to form an image of the source of light in the preparation. Most photomicrograms have been hitherto obtained by the use of the Microscope objective without the eye-piece; lately, however, very well made projection eye-pieces have been recommended. The best safeguard from any shaking of the instrument during the exposure is afforded by a triple layer of thick felt under each leg of the table on which the apparatus stands. No precise directions can be given as to the time of exposure necessary for the production of a good negative. By direct sunlight, with the strongest magnifications and sufficient weakening of the light by the filter, a few seconds are sufficient.

On the value of photomicrography the most contradictory opinions are held. Some think that in a short time it will quite drive drawing from the field, while others, taught by sad experience, are inclined to depreciate its importance. Both are wrong. Certain things will always remain to the draughtsman, while others belong exclusively to the photographer.

* Wracz, 1890, pp. 725–6. See Centralbl. f. Bakteriöl. u. Parasitenk., x. (1891) p. 132.

† Central-Ztg. f. Optik u. Mechanik, xii. (1891) pp. 262–3.

For photographic purposes, only thin preparations which lie as much as possible in one plane are suitable. For this reason diatoms have been the chosen subject of representation. Only the thinnest sections, as obtained by the most perfect microtomes, are suitable for photography. Of thicker preparations excellent drawings can be made. In not a few cases a certain thickness of the object is absolutely necessary, viz. when the essential details naturally lie in different planes. The draughtsman, by constant turning of the micrometer screw, combines the different planes into one; in photography such a process is impracticable. The discredit which has fallen upon photomicrography is for the most part to be ascribed to the ignorance and want of skill of those who would be always photographing objects which are absolutely unsuitable for photographic purposes.

(5) Microscopical Optics and Manipulation.

The Measurement of Lenses.*—The following is the valuable essay recently read by Prof. Silvanus P. Thompson to the Society of Arts:—Often have I regretted that the resources at the disposal of the Technical College, Finsbury, did not enable its staff to organize and equip a proper laboratory for optical measurements, and for the standardizing of optical instruments, in the same thorough and practical way in which they have now for more than ten years organized laboratories for electrical measurements. What Prof. Ayrton did ten years back for the City and Guilds Institute, in organizing a laboratory for electrical measurements, I have longed to do for optical measurement, believing that, when the opportunity should come, the work would be of as much benefit to the optical industries of London as the electrical laboratories of the City and Guilds Institute have been.

The exact measurement of optical quantities is no novelty: for in this branch of science precision has long reigned, if not in the lower branches of the industry, at least in the higher. And the laboratory methods of optical measurement are for the most part thoroughly worked out and known, though many of them unfortunately involve the use of expensive instruments and appliances.

An optical laboratory should possess the means of testing rapidly, accurately, and without too expensive appliances, such matters as the truth of plane surfaces, the curvature of curved ones, the focal powers of lenses, their aberrations and their aperture. It should have means of testing mirrors and prisms, as well as actual entire instruments. It should be able to state the results in terms available for future years by the employment of accurate fundamental standards.

With but one very small part of the subject of the work of the optical laboratory do I propose to deal to-night, namely, with the measurement of lenses. Lenses are used for many different purposes, and in varied functions and combinations. Measurements that would be important for some of these are utterly unimportant for others. For example, the condenser lenses used for magic lanterns are not wanted to be either aplanatic, achromatic, or rectilinear; their function being merely to collect the light which emanates from a certain luminous

* Journ. Soc. Arts, xl. (1891) pp. 22-39. Reprinted by the author's permission, and with his corrections.

patch, and spread it as nearly equally as possible over the area covered by the transparent slide, so that the whole is equally illuminated, and so that the light so transmitted shall be on the whole slightly convergent. To measure the aberrations or exact focal powers of such lenses would be a useless work.

However, it will be convenient at the outset to enumerate all the things which might be made the subject of measurement with respect to a lens or combination of lenses. These are no fewer than eighteen in number:—(1) Diameter, or linear aperture. (2) Thickness, or length from pole to pole. (3) Focal power, or its reciprocal the focal length. (4) Position of principal focal planes. (5) Position of optical centres ("principal points" of Gauss). (6) Angular aperture. (7) Chromatic aberration. (8) Spherical aberrations, lateral and longitudinal. (9) Chromatic difference of the spherical aberration. (10) Loss of light by reflexion from surfaces. (11) Absorption of light in transmission. (12) Illumination of field, central and marginal. (13) Complanity of focus (included in 7 and 8). (14) Degree of distortion of image (rectilinearity). (15) Cylindricity, or degree of astigmatism, including angle of axis of cylindricity. (16) Accuracy of centering. (17) Definition in margin of field (involved in 7, 8, and 16). (18) Refractive indices of materials.

Now, of all these varied matters, there are but three with which the present paper will deal: namely, the focal power of lenses, and the position of their focal planes and principal points.

By focal power I mean, of course, that property on which their convergency (positive or negative) depends, and on which in turn their magnifying (or minifying) action is dependent. It must be borne in mind, as a fundamental principle of elementary optics, that all that any lens or mirror (or combination of mirrors or lenses) can effect is to imprint a curvature on the wave-front of the light that enters it. If the wave is plane—i. e. consists of parallel rays, to use the old language—then the lens prints a curvature, positive or negative, upon it by virtue of which its march is changed, and made convergent or divergent. If the wave before impinging on the lens is initially non-plane, but either convergent or divergent, then the lens will alter the curvature of the surface, the resultant curvature on emerging being simply the algebraic sum of the initial curvature and the impressed curvature.*

The focal power is the curvature imprinted by the lens on a plane wave, and is the reciprocal of the true focal length. It is appropriately expressed in terms of the proper unit of focal curvature, the *dioptrie*.†

* All the ordinary formulæ of the text-books for lenses are more or less particular statements in symbols of this general rule; for example, the well-known formula

$$\frac{1}{v} = \frac{1}{u} + \frac{1}{f},$$

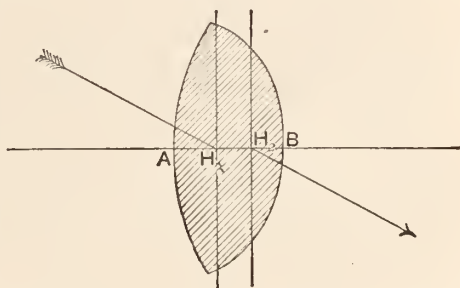
in which f is the focal length, and u and v the respective distances of two conjugate points serving as object and image. The reciprocal of a length is a curvature; so that this formula merely states that one curvature is the result of adding two other curvatures together. I have pointed this out in a paper in the 'Philosophical Magazine,' in Oct. 1889.

† The *dioptrie*, originally proposed by Monoyer as the unit of focal power of a lens, is now in international use, having been formally adopted by the International Medical Congress of Brussels. It is a unit of curvature, and as such may be used

The proper numbering of lenses in dioptries has been an enormous gain in one branch of the optical industries—that of the ophthalmists—and it is much to be wished that other lenses than those of spectacles should also be henceforth described in the same way.

Another important step has been the introduction of the conception of focal planes—a conception to which the use of the photographic camera has doubtless contributed its share. Less fully recognized, but none the less important, is the conception introduced by Gauss as the result of his studies in geometrical optics, that the properties of any centered combination of lenses might be represented by a system of planes and points which are, so to speak, the characteristics of the equivalent lens. A lens can be considered as having a single optical centre only when it is infinitely thin, or at least of negligible thickness. All thick lenses and combinations of lenses have two optical centres, described by Gauss as the two “principal” points (“Hauptpunkte”), which are considered as the places where the axis intersects two “principal planes.” These principal planes are at a certain distance apart, and equidistant between the two principal foci at the back and front of the lens. They possess certain properties most useful in the geometrical treatment of lens problems, and act as though the light, however obliquely it may be crossing the lens, were transferred straight from one to the other. The two “principal” points, or optical centres, possess the property that light proceeding from any direction towards the one of these points passes out from the lens combination as though it had passed through the other. Fig. 8 shows a thick lens (in diagram), in which the two principal points of Gauss are marked H_1 and H_2 , with the two principal planes drawn through them. These two points, together with the two principal foci,

Fig. 8.



completely determine the action of the lens. When the positions of these four * cardinal points are known for any lens or lens-system, then all is known that is necessary for a complete discussion of the formation of images for all objects lying near the principal axis. The true focal length is the distance from either of the two principal planes to the corresponding principal focus; the back focus and the front focus being

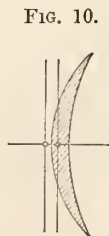
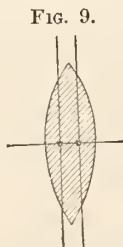
for other purposes than focal powers—for example, to express the curvatures of surfaces. Unit curvature is taken as the curvature of a circle of one metre radius. Or a lens having a metre focal length is described in modern language as having a power of one dioptrie. A lens having half a metre as focal length has a power of two dioptries.

* If the lens system is not bounded by similar media on its two faces—for example, if one side is bounded by air and the other by water—the two optical centres are shifted away from the two principal planes towards the denser medium, and are known as “nodal” points. In this case there are six cardinal points to consider.

equidistant each from its own optical centre. But hitherto it has been found difficult to ascertain the position of the principal planes of a lens combination. Optical instrument makers generally have no information on the subject that they can furnish. They can tell us approximately the focal length, but they cannot, or do not, tell us the position of the optical centres or principal points from which this focal length is to be reckoned. Beginners in microscopic work, when they come upon an objective marked "1/4-inch," expect to find that the object must be placed 1/4 in. below the front surface of the lens, and are often puzzled to find that the distance is perhaps only 1/10 in. Naturally they ask the question, from what point does the maker measure his quarter of an inch? The correct answer is that the 1/4 in. should be measured from the principal plane which corresponds to the front focus of the lens. But where this principal plane lies is never marked on the brass mount of the lens, though it ought to be. Again, the beginner often asks what is the correct way to reckon the true tube-length of the Microscope between objective and eye-piece? Must he measure from the lowest point of the eye-piece to the highest point of the objective, or how? The right answer is that the true distance between objective and eye-piece is not the mere length of the tube, but is the distance between the second principal plane of the objective, and the first principal plane of the eye-piece. But how is the unfortunate possessor of the instrument to measure this if the constructor has omitted to mark on the eye-pieces and objectives the positions of the principal planes?

It is one of the purposes of this paper to describe an instrument for measuring lenses, and ascertaining the precise position of these principal planes. Therefore, a few more preliminary words about the principal planes and the two Gauss-points through which they pass, will be appropriate.

In ordinary single lenses, if not very thick in proportion to diameter, the distance between the two principal planes is approximately one-third of the thickness of the lens at its middle. Exact formulæ are given in various modern treatises on geometrical optics. In lenses that have their two faces of different curvatures the principal planes do not lie symmetrically between the two poles* of the lens, but are shifted toward the more highly curved face, or even beyond it. In plano lenses,

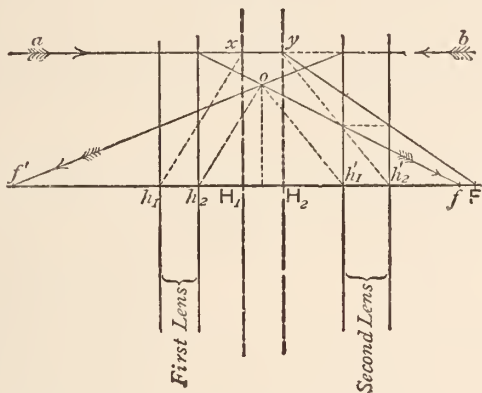


whether convex or concave, one of the two principal planes is a tangent to the curved face. These matters are illustrated by the sketches in figs. 9, 10, and 11.

* I have used this term for years to denote the middle-points of the two faces of the lens, and find it very convenient.

If the positions of the four cardinal points are known for any two lenses separately, then, when the lenses are placed at any given distance apart, the positions can be found for the four cardinal points of the combination. The geometrical construction is very simple, and is illustrated in fig. 12. Let $h_1 h_2$ be the two principal points of a lens,

FIG. 12.



and f its principal focus for light passing through it to the right. Let $h'_1 h'_2$ be those of a second lens, and let f' be its principal focus for light passing the other way. It is required to find the position of the principal points and of the principal focus of the equivalent lens. Consider any ray-path ab parallel to the axis. Light travelling along from a will, after passing the principal planes of the first lens, turn towards f . Similarly, light passing the other way from b , after passing the second lens, will turn towards f' . These paths cross at o . Join oh_2 and oh_1 ; and draw h_1x parallel to oh_2 ; and h'_1y parallel to oh'_1 . The planes xH_1 and yH_2 drawn through x and y will be the desired principal planes. And the resultant focus F is found by considering the ray which starts from a and passes through o towards f , and remembering that, as it passes through the second lens, it will be shifted forward through the distance between the planes $h'_1 h'_2$, and turned as though it came from y . A little consideration will show that if the two lenses were close together the width $H_1 H_2$ will be the sum of the widths $h_1 h_2$ and $h'_1 h'_2$; whilst if the two lenses are moved wider apart H_1 and H_2 will come nearer together, and may even cross past one another. If the lenses are placed at a distance apart equal to the sum of their focal lengths, H_1 and H_2 will not only have crossed planes, but will have separated to an infinite distance apart.

The formulæ for calculating the resultant focal length and resultant width between the principal points for a combination of two lenses at a distance apart, are as follows:—

$$\text{resultant } f = \frac{f_1 f_2}{f + f_2 - a};$$

$$\text{resultant } w = w_1 + w_2 - \frac{a_2}{f_1 + f_2 - a};$$

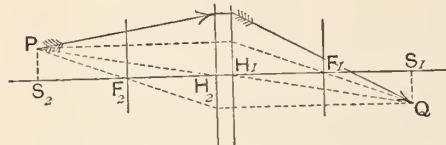
where a is the distance between the lenses, f_1 and f_2 their focal lengths, w_1 and w_2 the widths between their principal points.

From these formulæ it follows that the resultant focal length of a combination of two positive lenses when separated by an interval is always greater than the reciprocal of the sum of their reciprocals, and increases as the lenses are separated. The resultant width between the principal points decreases from the value $w_1 + w_2$ down to nothing, and then increases negatively, becoming infinite when $a = f_1 + f_2$, and again becoming positive and finite when a exceeds that value.

If the optical combination is not achromatic, then the positions both of principal planes and of principal foci will be, in general, different for lights of different colours.

There exists yet another pair of points and planes, having special properties that should be noted. These are the points situated on the axis beyond the principal foci at distances respectively equal to the true focal length on either side. They are marked S_1 and S_2 in fig. 13,

FIG. 13.



being conjugate and symmetrically situated. Toepler, who first called attention to these two points, called them by the not very apt name of negative principal points (negative Hauptpunkte). I call them the two *symmetric* points, and the planes through

them the *symmetric* planes. They possess the very useful properties that any object in one has an image of equal size, inverted, in the other, and that any ray which crosses one of them at any distance from the axis will, after traversing the lens, cross the other symmetric plane at an exactly equal distance from the axis, but on the other side of the latter.

I have now cleared the way for discussing the methods that have been hitherto used or suggested for measuring the focal properties of lenses. Unfortunately, most of the ordinary methods of focometry which are in accepted use are based on the assumption that the lens may be treated as of negligible thickness, and in some others one has to make assumptions beforehand as to the probable width between the principal planes. This is easy enough in the case of a single lens, but for compound lenses the principal planes come in most unexpected positions, at an unknown width apart. After I have enumerated the methods of focometry, and briefly described each, I will describe a new method, and an instrument for carrying it out.

METHODS OF FOCOMETRY.

The methods of focometry may be classified under six general heads; and under these may be grouped the several varieties adopted by different authorities.

I. *Methods of Direct Focal Search.*—(a) *Objective Methods.*—The classic simple method of ascertaining the principal focus of a lens or optical combination, applicable only to positive lenses; consisting in sending rays from any very distant object through the lens, and search-

ing for the real image which is received upon a suitable surface, preferably that of a semi-transparent screen.

(b) Berger's * Method.—A variety of the preceding, in which an illuminated object and a collimating telescope at a finite distance are substituted for an indefinitely distant object, and the real image at the principal focus is sought by means of an observing Microscope.

(c) Maskelyne's † Method.—A telescope, fitted with crosswire eyepiece, is focused upon an object at indefinite distance. The (positive) lens under examination being then clamped over the object-glass, it is pointed to a near object, which is moved to such a position as will give an accurate image in the telescope, the position of the object being that of the principal focus of the lens.

(d) Merz's ‡ Method.—A variety of the preceding, adapted to negative lenses. The telescope, with the lens under examination fitted in front of the object-glass, is focused upon an object at an indefinite distance, and then the lens being removed, is pointed to a near object which is moved to a position giving accurate focus.

(e) Kerber's § Method.—The positive lens being placed in front of an illuminated slit, it is moved to such a position that a slab of glass with parallel faces introduced into the path of the emerged rays produces, on being tilted, no change in the apparent position of the slit as viewed in a telescope; this being a test of parallelism of the rays.

None of the foregoing methods are applicable to very short focus lenses, and they give no information as to the Gauss points.

(f) Pendlebury's || Method.—The positions of each of the two principal foci are found objectively, and then the respective distances are found from these to two conjugate points by inserting a luminous object and finding, objectively, its image. Then calling these two distances p and q , the true focal length is found by Newton's rule as a geometrical mean between them. After this calculation has been made, the distance between the two principal points can be found by subtracting twice the true focal length from the distance between the two principal foci.

II.—*Methods of Magnification.*—(g) Ramsden's Method.—Measurement is made of the size and distance of the real image formed at the conjugate focus of an object of known size, at known distance: and from these the focal depth is calculated. This method assumes the lens to be of negligible thickness.

(h) Meyerstein's ¶ Method.—This is a modification of Ramsden's

* Berger, 'Apparat zur genauer Bestimmung der Brennweite von Objectivgläsern,' Zeitschr. f. Instrumentenk., vi. (1886) p. 272.

† After considerable search I am unable to find any writing of Maskelyne's which describes the method which goes by his name. The same remark applies to Ramsden's method.

‡ Merz, 'Ueber einen neuen Apparat zum Messen der Brennweite,' Pogg. Ann., lxiv. (1845) p. 321.

§ Kerber, 'Verfahren zur Bestimmung der Brennweite von Linsen,' Zeitschr. f. Instrumentenk., i. (1881) p. 67.

|| Pendlebury, 'Lenses and System of Lenses' (London, 1884), p. 82.

¶ Meyerstein, 'Apparat zur Bestimmung der Brennweite sphärischer Linsen und Linsensysteme,' Wied. Annalen, i. (1877) p. 315; and Carl's Repertorium, xiv. (1877) p. 363.

method to meet the ease of thick lenses. The lens is placed between an object and a screen fixed at more than four times the focal length apart. Measurement is made of the size of object and image, together with the distance of the lens from one of them. The lens is then reversed end for end, and is displaced longitudinally until the same magnification is obtained as before on the same screen. All assumptions about the Gauss points are thus eliminated, for it is clear that if in the second observation, after reversing the lens, the same magnification is obtained as in the first, the second principal point now occupies the position which the first principal point previously occupied, and *vice versa*. From the magnification, the distance between object and image, and the measurements of the displacement of the lens, the true focal length is calculated. Dr. Meyerstein describes a special instrument for carrying out this method. This method was devised in 1844, but not published until 1877, after the same principle had been independently discovered and described by Dr. Hoppe.*

(i) Hansen's † Method.—An object of given size being chosen, the positions of the lens are found which give (real) images of linear magnitudes respectively equal to that of the object multiplied by 1, 2, 3, &c.; and from two (or more) of such observations, each of which requires a series of double adjustings, the focal length and the distance between the principal points are calculated.

(j) Mergier's ‡ Method.—This is an elegant mode of carrying out one of Hansen's suggestions. The two symmetric points are found by trial and double adjustment, as in Silbermann's method mentioned below, the magnification here being unity. Two micrometers serve as respecting object and as receptive surface for the image. This adjustment being made, then, in order to produce an image in the same place as previously but of double magnitude, it is sufficient to displace the lens through a distance equal to the focal length, and the object through exactly half this distance. This is accomplished by simple mechanical means, with two screws connected by wheel-gearing.

III. *Methods of Unit Magnification.*—These methods constitute a special case of II., but are quite distinctive.

(k) Silbermann's § Method.—In this method the lens (positive) is placed at the middle of a graduated bench, upon which two transparent micrometers are placed on either side, so that the image of one micrometer falls upon the other. By a well-known theorem, the total distance between object and image will be a minimum, when the distance between them is equal to four times the focal length, and each is situated at one of the symmetric points of the lens. The

* Hoppe, 'Ueber die Bestimmung der Haupt- und Brennpunkte eines Linsensystems,' Pogg. Annalen, *etc.* (1876) p. 169.

† Hansen, 'Untersuchung des Weges eines Lichtstrahls durch eine beliebige Anzahl von brechenden sphärischen Oberflächen,' K. Sächs. Gesellsch. f. Wissenschaften, xv. (1871).

‡ Mergier, 'Nouveau focomètre pour la détermination des constantes optiques des systèmes dioptriques en général,' Séances de la Société de Physique, 1887, p. 193.

§ Silbermann, Comptes Rendus, xiv. (1830) Feb. 22, p. 310. See also Verdet, 'Cours de Physique,' wherein it states that this instrument was referred to a Commission, consisting of MM. Arago, Babinet, Biot, and Pouillet. No reference to any report of this Commission can be found.

operation of finding these symmetric points consists, then, in a series of double adjustments of the following kind:—One of the micrometers being placed at a distance judged approximately as twice the focal length, the second micrometer is then moved, until upon its surface an exact image of the first is formed. If, on comparing the size of the divisions of this image with those of the surface on which it falls, it is found that they do not coincide, but are either magnified or minified, the distance of the first micrometer is either increased or diminished, and the second micrometer is again adjusted to the new position of the image, and a fresh comparison made. By successive trials and approximations the symmetric points are approached; and, when so found, the distance between them is measured, and one-fourth of it taken as the focal length. The method is open to the objections (1) that it is inapplicable to thick lenses, as it does not take into account the distance between the Gauss points, and (2) that it requires a tiresome series of double adjustments. The simple modification of this method, suggested by Webb,* needs no notice here.

(l) Donders's † Method.—Donders improved the method of unit magnification by substituting for the series of double adjustments a simpler mode of equalizing the size of object and image. He used as object an opaque screen provided with perforations, the linear dimensions of which from one to another were measured with a Helmholtz's ophthalmometer. The lens to be measured being placed in front of this object, an image is then formed on a translucent screen, and the lens is then moved to increasing distances until the size of the image, as measured by the ophthalmometer, is equal to that of the object.

(m) Snellen's ‡ Method.—This method, which closely resembles that of Donders, is carried out by the aid of an instrument called a *Phakometer*, consisting of a graduated bench at the middle of which the lens is placed. No ophthalmometer is used to measure the sizes of object and image, a translucent screen figured with marks serving to detect any want of equality between the sizes of image and object. It is assumed that the lens has a single optical centre at its centre of figure, and a mechanical adjustment serves to move the object and the screen at equal rates from the lens at the centre. The scale is divided to read off direct in *dioptries* the focal power of the lens. Snellen applies the method to negative lenses and long-focus positive lenses by placing them between two positive lenses of equal and known focal power; and in the case of plano-convex and meniscus lenses, he recommends that to secure symmetry, such lenses should be taken in pairs, back to back, and measured together.

IV. *Methods of Approximate Unit Magnification.*—(n) Bessel's § Method.—In this method the object and the apparatus to receive the image are placed at a distance from one another, exceeding four times

* Webb, 'Literary Gazette,' 1857, p. 1101; and Fortschritte d. Physik, xiii. (1857) p. 276.

† Donders, 'Bepaling van den Brandspunt-afstand van Lensen,' Versl. en Mededeel., xv. (1863) p. 402.

‡ Snellen, 'De Phakometer, ter bepaling van focus en centrum van lenzen,' Maandblad voor Natuurwetenschappen, vii (1876) p. 23.

§ Bessel, 'Astronomische Untersuchungen,' i. p. 137.

the focal length, and the (positive) lens is placed between them. Two such positions of the lens can be found for either of which the distance between the two conjugate foci is the same. Bessel gives a formula for deducing the focal length from the measurements of the various distances. The method assumes the distance between the Gauss points to be known beforehand, and therefore fails to give any information on the more difficult point to be determined. The advantages of the method are that no measurements have to be made from the curved faces of the lenses, and that none have to be made of the sizes of optical images.

(o) Oudemans' * Method is simply the method of Bessel carried out by means of a special apparatus, consisting of a simple graduated bench, and hair micrometers. Oudemans gives approximate formulæ for calculating the distance between the Gauss points, for insertion in Bessel's formulæ, but confesses that this procedure fails in the case of many lens-combinations.

(p) Hasselberg's† Method.—In applying Bessel's plan, Hasselberg employs as objects the real images of spectrum lines as formed in the focal plane of the eye-piece of a spectroscope. He compares to some hundredths of a millimetre, the performance of a Zeiss's objective constructed of ordinary glass, but assumes the Gauss points by approximate calculation.

(q) MacGillavry's‡ Method.—This elegant method departs from Bessel's in that it requires measurements to be made of the respective sizes of object and image, as well as of the distance between them, and of the displacement of the lens between the two intermediate positions of adjustment to exact focus. But by this means all assumptions or estimates about the distance between the Gauss points are avoided. MacGillavry gives three formulæ from each of which this unknown quantity has disappeared by elimination; the true focal length being given in terms of the quantities directly measured, namely, from the relative sizes of object and image in the two positions, and the change in any one of the three measured lengths. Apart from the experimental difficulty of accurately measuring the magnification, MacGillavry's method appears to be very satisfactory.

V. *Method of Approximate Interior Unit Magnification*.—(r) Cornu's§ Method.—This is one of a group of possible methods in which the respective distances from their related principal foci of two conjugated points are measured, and the true focal length (which is their geometrical mean) is calculated from them; the peculiarity of Cornu's plan being that the two conjugate points employed are close to the two Gauss points, one of them being always interior to the lens. The lens is temporarily marked with ink-lines upon its faces, and the experimental process consists in observing by a reading Microscope of sufficiently

* Oudemans, 'Sur la détermination des distances focales des lentilles à court foyer,' Archives Néerlandaises, xiii. (1877) p. 149.

† B. Hasselberg, Bull. de l'Académie des Sciences de St. Pétersbourg, xxxii. (1888) p. 142; and Beiblätter, xii. (1888) p. 782.

‡ MacGillavry, 'De bepaling der focaal-afstanden van samengestelde optische stelsels,' Maandblad voor Natuurwetenschappen, v. (1875) p. 73.

§ Cornu, 'Détermination expérimentale des éléments principaux d'un système optique,' Journal de Physique, 1re série, vi. (1887) p. 276.

long focus the positions in space of the principal focus of the lens, the marks on the nearer face, and the internal vertical image of the marks on the further face. From the distances thus measured, together with a measurement of the thickness of the lens, the true focal length, as well as the distance between the Gauss points, can then be calculated. In practice, the direct measurement of the thickness of the lens is avoided by the device of reversing the position of the lens and repeating the three readings from the reversed faces. M. Cornu describes an apparatus constructed for him by Duboseq for carrying out these measurements.

(s) *Mebius's* Method.*—This is a modification of the method of Cornu for the particular case of negative lenses, and needs no extended notice here.

VI. *Method of Obliquity of Rays.*—(t) *Moser's † Method.*—This method is based on the principle that any ray which on entrance passes through the first Gauss point at any given obliquity with respect to the principal axis emerges with unchanged obliquity, but displaced, as if it had passed through the second Gauss point. To determine these points the experimental process consists in a series of approximations derived from measurement made of the magnification.

Of the various methods thus briefly reviewed, only those of Pendlebury, Meyerstein, MacGillavry, and Cornu fulfil the conditions of determining the values of both f and κ without double adjustments. Doubtless, each has its advantages for particular cases. Yet it appears worth while to follow out another method which seemed to possess some advantages over any yet suggested.

A NEW FOCOMETRIC METHOD.

In the new method of focometry which the author has devised, direct methods of measurement of lengths only are used; and double adjustments are avoided. The method consists in the direct determination, *firstly*, of the two principal foci by placing a transparent micrometric screen at each; and, *secondly*, when these have been found, the two symmetric points by moving the two screens by a double screw motion through equal distances until each is the image of the other. The true focal length (f) and the distance (κ) between the Gauss points are therefore given by simple subtraction of scale readings.

Choice of the Symmetric Points.—It is easy to show that in any determination of focal lengths, the most favourable position for an experimental measure of any two conjugate points is when these occupy the symmetric points; provided the experimental determination of the two conjugated foci is *assumed* to be of equal difficulty.

Let p and $-q$ be the respective distances of the point-object and point-image from the two corresponding principal foci. Then by Newton's rule, we shall have

$$f^2 = pq; \quad (1)$$

where f is the true principal focal length.

* Mebius, 'Détermination expérimentale des éléments principaux d'une lentille divergente,' Journal de Physique, 2me série, ix. p. 511.

† Moser, 'Methode die Brennweite und optischen Hauptpunkte von Linsen zu bestimmen,' Pogg. Annalen, lxxiii. (1884) p. 39.

If in the determination of the lengths p and q we make errors of measurement, respectively Δp and Δq , there will result an error of Δf in the calculation of the focal length, having a value determined by the equation

$$(f + \Delta f)^2 = (p + \Delta p)(q + \Delta q), \quad (2)$$

or

$$f^2 + 2f\Delta f + \Delta^2 f = pq + p\Delta q + q\Delta p + \Delta p\Delta q. \quad (3)$$

Subtracting (1) from (3) and neglecting small quantities of the second order, we have:—

$$2f\Delta f = p\Delta q + q\Delta p. \quad (4)$$

Hence, divided by $f^2 = pq$ we get

$$\frac{\Delta f}{f} = \frac{1}{2} \left(\frac{\Delta q}{q} + \frac{\Delta p}{p} \right), \quad (5)$$

or the percentage error in f is the mean of the percentage errors in p and q . Hence, since Δp and Δq are obviously of the same order of magnitude, if we write Δm for the arithmetical mean of them, and assume that each of them is equal to this value, we get from (4)

$$\Delta f = \frac{1}{2} \frac{p+q}{f} \Delta m \quad (6)$$

which shows that for a given mean error Δm and a given focal length, the error made in determining this focal length will be proportional to $p+q$. Hence those values of p and q which make $p+q$ a minimum will make the error Δf a minimum. And, as $pq = f^2$ is a constant for a given lens, it is obvious that the case of minimum value of $p+q$ is when $p = q$; this being the case when the conjugate points are at the symmetric points.

The assumption made above that the experimental difficulty of determining the position of a conjugate focus is equal for conjugate foci in any position, is, however, hardly justified in practice, for in all laboratory experience it is admitted that it is more difficult to ascertain with precision the position of an image (real) which is remote from a lens than that of one near the lens. In fact, the experimental location of the image is mainly delimited by the sharpness of the crossing of the rays, and the tangent of the angle at which the extreme rays cross is inversely proportional to the distance from the lens. The aperture of the lens then limits the accuracy of determination of foci at great distances. The larger the aperture the more accurately (assuming spherical aberration above) will be the delimitation of the foci; but the larger the aperture, the greater do spherical aberrations become. The error in determining q may arise at either end of the measurement; it is more likely to occur at the end most distant from the lens than at the principal focus. If it be assumed that the probable magnitude of an error Δq made in estimating the value of q is proportional to the distance of this focus from the lens, then we may write Δq as proportional to $q+f$, and similarly Δp as proportional to $p+f$. Substituting these values in (4) we get

$$2f\Delta f \propto p(q+f) + q(p+f)$$

and dividing by f and collecting, we get

$$\Delta f \propto f + \frac{1}{2}(p + q).$$

This is still a minimum (for positive values of p and q) when $p = q$, or when the conjugate foci are taken at the symmetric points.

Principle of Focometer for determining the Focal Planes and Principal Planes of any given (Positive) Optical Combination, such as a Microscope Objective, or other Lens.—The abstract principle of this focometer was described as follows by the author two years ago, in a memorandum accompanying an application made to the Royal Society for a grant in aid of the construction of the apparatus:—

“Let $A B$ (fig. 14) be the objective (or lens); $H_1 H_2$ its principal points; $F_1 F_2$ its principal foci; and $S_1 S_2$ the two symmetric points

FIG 14.



situated each at double the focal distance from the respective principal points, $S_1 S_2$ are conjugate points, and the planes through them are planes of unit magnification.

“Suppose a parallel beam to be sent (from a lamp provided with a reticle in front of it and a collimating lens, all placed in air at some convenient distance away) through $A B$ from left to right. An image will be formed at F_1 , thus determining that point. Then, with the same source removed to a distant point on the right, send a parallel beam from right to left, thus determining F_2 . Small glass plates, having micrometers cut on surfaces (respectively) nearest to $H_1 H_2$, and each provided with a reading lens behind, should be used to receive these images, and to ascertain their precise position in space. The said micrometers should be mounted on supports sliding along a suitable bench, over the middle of which the objective has been clamped in a special support. The micrometers, or, at least, one of them, should be so arranged that they can be thrown out of the axis laterally when not wanted. They should be provided with verniers to read off their positions on the bench. They should also be furnished with clamps, which, after each has been once set at its principal focus, will permit it to be clamped to a screw below on the bench. The distance from F_1 to F_2 is equal to $2f + x$ (where f is the true focal length and x the unknown distance between the two principal planes).

“Now, let there be a gearing, such as a right and left-handed screw, which will enable the observer to move the two micrometers from F_1 and F_2 at exactly equal rates outwards. When one of them arrives at S_1 the other will at the same moment arrive at S_2 , and this will be

known by observing through the reading lens attached to one micrometer the inverted image of the other, coincident, but reversed in position (exactly as in Silbermann's old form of focometer). The equality of object and image in size—known by the fitting of the micrometer scales—will serve to check the correctness of the observation. The distance from S_1 to $S_2 = 4f + \kappa$. Hence $\kappa = 2F_1F_2 - S_1S_2$; and $f = F_1S_1 = F_2S_2$. By measuring off backwards from F_1 a distance equal to S_1F_2 , the point H_2 is arrived at. Similarly H_1 is arrived at, and these points can be marked off on the outside of the tube of the objective."

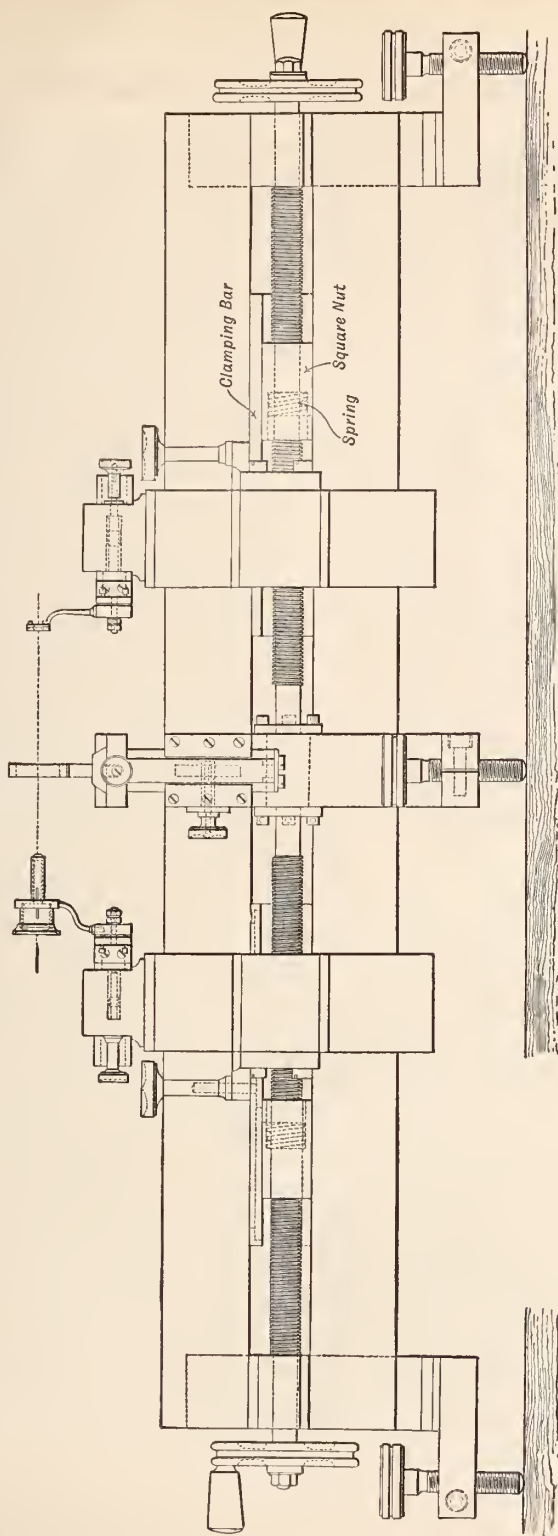
Description of the Instrument.—In accordance with the foregoing project, the author designed an instrument which he terms a Focometer. It was constructed by Messrs. Nalder Bros., of Clerkenwell, to whom the author is indebted for many useful suggestions embodied in the apparatus. The construction is shown in the accompanying figures.

The support for the lens or combination of lenses to be examined is fixed at the middle of a bench made of two parallel girders of gun-metal, each 670 mm. in length, placed vertically above one another, and secured together both at their ends and at the middle. The highest and lowest faces of this double girder are bevelled at 45° , and a scale of millimetres is divided along the front face at the upper edge. This girder frame is shown from the back in fig. 15, in end view in fig. 16. The support for the lens can be raised by a dovetail slide worked by a rack, or moved horizontally transversely to the bench by another dovetail slide furnished with a screw motion, as shown in figs. 15 and 16.

The travelling supports for the micrometers are two solid pieces of brass, which fit over the bevelled edges of the girders and slide without any looseness of motion along the frame. Each bears a vernier to read off its position on the bench, and each is furnished at its upper point, as shown in fig. 15, with a horizontal slide for fine adjustment, worked by means of a screw of fine pitch; the position of the horizontal slide being read off by means of a vernier against a short scale cut upon the face of the support. Except when the clamps described below are applied, each of these supports is so far free that it can be pushed along the bench by hand, but is fitted to slide so accurately that it cannot be shifted by any chance touch.

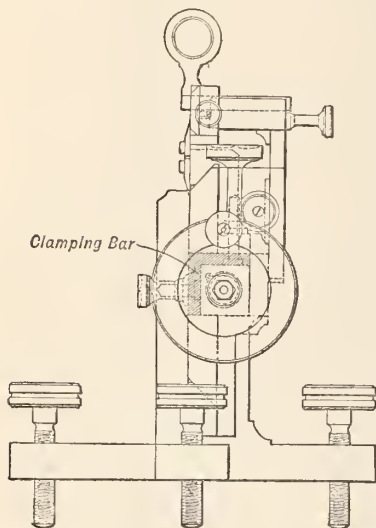
Between the parallel girders, running from end to end of the apparatus, is a double screw, the two halves being respectively right and left-handed, each accurately of a pitch of two millimetres. This screw, the function of which is to shift the two supports for the micrometers, is furnished at each end with a large milled head, and with a driving handle. The screw is of steel. It was constructed in two separate parts, which were then united by being securely riveted into a short cylinder of steel of larger diameter. This cylinder runs through a bearing in the central piece of the frame of the instrument, and is secured in position between two fixed collars of steel, which are seen edgewise in fig. 15. These collars are screwed up sufficiently tightly to prevent any end play. At the two outer ends the screw passes through two bearings in the end supports, which admit of longitudinal play so as to allow for any difference of expansion between the screw and the frame of the instrument.

FIG. 15.



The manner in which the driving motion is communicated from the screw to the two travelling supports is peculiar. A device was needed which would admit of the travelling supports being independently moved to any positions when not clamped to the screw, and of being clamped in any position to the screw, so as to be driven by it without backlash. These conditions were finally fulfilled in the following manner. Upon

FIG. 16.



each half of the screw is placed a massive gun-metal nut, about 50 mm. long, and of square section 25 mm. in the side. The lower face of this nut slides upon the upper face of the lower girder, and this prevents it from turning; it is also prevented from turning by the interposition, between its upper face and the lower face of the upper girder, of a long slotted rectangular flange of brass which constitutes part of a clamping bar. Each nut is bored out with a short cylindrical cavity. Within this are inserted a spiral spring of steel wire, and a second nut which, though capable of longitudinal play, is prevented from turning by the insertion of a key into a key-way. The introduction of this second nut, with a strong spring between it and the main nut, is a mechanical device originally due

to Sir William Thomson, P.R.S., for preventing backlash. The slotted clamping bars mentioned above are of brass, each 176 mm. long. Each is, as may be seen from figs. 15 and 16, of L-shaped section, fitting over, and in front of the square nut. The upper horizontal flange which comes between the top of the nut and the under side of the higher girder is of accurate fit, and is slotted out to receive beneath it the head of a clamping pin. This pin, passing vertically through a projecting lug of the travelling support, enters the threaded shaft of a clamp-screw which bears at its top a milled head. When this is turned, the head of the clamping pin is raised and clamps the slotted bar to the lug of the travelling support. The vertically-situated flange of each of the L-shaped clamping bars fits accurately into the space between the upper and lower girders, and it also is slotted to admit through it a clamping pin which projects horizontally from the square nut. A clamping screw with milled head screws on to this pin, and clamps the slotted bar to the square nut. It is shown in fig. 16 projecting to the left. In order that the turning of the long screw may drive the two travelling supports, it is requisite that each should be clamped to its slotted bar, and that each slotted bar should be clamped to the square nut. The object of using such long clamping bars instead of mere short pieces is to enable the travelling supports to be clamped

when at unequal distances from the centro of the apparatus, the two square nuts being always situated symmetrically at equal distances from the centre.

The micrometers and other appliances for receiving the focal images are of three different kinds.

The first kind is shown on the left-hand support of fig. 15. It consists of a small bevel-edged disc of glass, fixed in the end of a narrow tube, and provided with a reading lens or positivo eye-piece of about 38 mm. focal length. Upon the outer surface of the glass disc is ruled a scale divided into fifths of millimetres. This micrometric arrangement is convenient for receiving a focal image, as formed at the back of a microscopic objective, at a point at some distance down the tube in which the objective is mounted.

The second kind, shown in fig. 15, on the right-hand support, consists of a rather larger disc of glass, mounted in a metal rim, which is cut away at two places. Upon the front face of this disc, a micrometer scale in fifths of millimetres is also ruled, and one-half the disc is silvered over. This arrangement is convenient for use with larger lenses, and for service as an object, in which case it is illuminated from behind. When making determinations of microscopic objectives it is found convenient to use one micrometer of the second kind opposite the front of the objective, and one of the first kind at the back of the objective; the pieces being mounted as shown in fig. 15. Each of the micrometers can be shifted laterally out of the line of the lens under measurement, the arm which carries the micrometer being fastened to a collar furnished with a small handle, as shown in figs. 15 and 16. This collar is guided to move in a plane orthogonally to the optical axis of the apparatus by an adjustment of three abutting screws. These three abutting screws are not shown in fig. 16, but the heads of two of them are shown in profile in fig. 15; being situated behind the collar bearing, which receives the curved supporting stem of each of the two micrometers. These bearing-collars are provided with stops to enable the micrometers to be brought up accurately to their former position after having been thrown out laterally.

A third arrangement, not shown in fig. 15, is used only for large lenses, and consists of a grooved metallic ring mounted on a curved arm upon the top of the travelling support. Over this grooved ring is stretched a piece of thin paper, which, after having a millimetre scale marked upon it, is rendered nearly transparent by the application of varnish. Two such micrometers are used—one at either end—when measurements are to be made upon camera lenses, and other lenses having a focal length of several centimetres.

The holder, fitted upon the central support, as shown in figs. 15 and 16, for carrying the lens, is cut with the Royal Microscopical Society's standard screw, so as to receive any microscopic objective. For other small lenses an adapter, provided with the same screw, is used, and the lens is temporarily fitted into the adapter by means of a cork ring. For large lenses a V-shaped appliance is substituted for the screw holder.

In order to know the position of the lens itself with respect to its focal and principal points, it is necessary to ascertain the scale-reading

corresponding to some fixed point on the lens, or on its attached mounting. This might be done by end-measurement, by bringing one of the micrometers up into actual contact with one pole of the lens; but such a mode of proceeding is inadvisable for several reasons. It was therefore decided, when the instrument was being designed, to adopt such a construction as would permit of direct determinations by means of a delicate plumb-line. With this object, the general form of double girder was adopted, so that the scale might be engraved on the front of the vertical face. By reference to the end elevation in fig. 16, it will be seen that the optical axis of the apparatus is arranged to be in the same vertical plane. Moreover, the micrometers are so arranged that in each case a plumb-line can be hung directly against the actual face of glass or paper upon which the micrometer is engraved. As plumb-line, a thin silk thread with a small leaden sphere at the end of it is used. When the instrument is properly levelled, the plumb-line can be applied to read off directly on the scale the actual position of any of the micrometers; and so by comparison with the readings of the verniers of the travelling supports is obtained the zero reading for use in future measurements.

It was consequently necessary to furnish the instrument with levelling screws. There, however, arose a small mechanical difficulty; for an instrument of this shape would not be very stable if provided with one foot at one end, and two near together at the other. It is therefore provided with four levelling screws, one at each end and two at the two ends of the central support. In practice, this arrangement is quite workable; and it is found convenient first to adjust the level of the girders lengthways by the end screws, then to adjust transversely by the other screws. The frame is so solidly made that there is no fear of racking it by unequal weight upon the four screws; the wooden top of a strong laboratory table is never so rigid as to make any fine adjustment necessary.

Mode of using the Focometer.—The mode of procedure in using the instrument is as follows:—The lens to be measured having been secured in the central support, it is then adjusted in position so as to be accurately in the axial line between the two micrometers. The clamps of the two travelling supports are left loose, being only applied when required. One of the micrometers (in practice, that shown on the left in fig. 15) is then thrown out laterally, and a beam of parallel light is thrown through the lens (from left to right, as seen in fig. 8), so as to form an image at the first principal focus. In practice, this is done as follows:—A compound lens, which is to be used as a collimator, is placed in direct sunlight, and at the focal point, where the image is formed, is placed a piece of ground glass, coarsely ruled with black lines. When this reticle is set in its exact position with respect to the collimating lens, the combination is placed at one end of a long room, about 40 feet long, with a paraffin lamp behind the reticle to illuminate it. The parallel beam thus issuing from the collimating lens is received on the focometer about 20 feet away.

The travelling support on the right (fig. 15) is then brought up by hand and adjusted so that the micrometer is approximately at the principal focus. It is then clamped to the screw, and, using a positive eye-piece to aid the vision, the micrometer is accurately adjusted to the

focus either by turning the main serew, or by the fine-motion serew on the travelling support. This first adjustment having been made, the clamps are then unfastened, and the micrometer is thrown out laterally.

A parallel beam is then thrown in a similar fashion in the reverse direction through the lens, and the second micrometer is thrown into line and is brought by a similar process to the second principal focus.

The plumb-line is then applied to ascertain the position of some fixed point of the lens, and to read off the positions of the micrometers, which are replaced in their axial positions: or, if the zero readings of these are known, their positions are ascertained from the readings of their respective verniers.

These three readings having been made, both the travelling supports are clamped to their respective nuts on the main screw. The screw is turned so as to cause the micrometers to travel outwards. The observer, looking into the eye-piece of the micrometer on the left, sees an inverted image of the other micrometer come into view, and, as the screw is turned, the micrometers reach a certain position when both sets of dividing lines are in focus in the same field without any parallax. This position can be very accurately ascertained by shifting the eye slightly from side to side of the lens. The two micrometers now occupy the two symmetric points, and their positions are observed either by plumb-line, or by the readings of their respective verniers.

The simple method of calculating by subtraction of scale readings the true focal length f and the distance between the two Gauss points, has been given above.

Results of Measurements made with the Focometer.—The following examples are given of measurements made on lenses. In all cases here recorded a red light was used, a ruby glass being interposed.

(1) Small Hemispherical Lens, 12 mm. aperture, by Cooke and Sons.—Front of hemispherical face taken as point of reference A. Preliminary experiments with plumb-line showed that F_2 is 76.1 mm. behind zero of vernier Z_2 , and F_1 is 49.6 mm. in front of zero vernier Z_1 .

Readings of verniers for principal foci are:—

$$\begin{array}{rcl} Z_1 & = & 356.55 \\ & - & 76.10 \\ \hline & & 280.45 \end{array} \quad \begin{array}{rcl} Z_2 & = & 199.20 \\ & + & 49.60 \\ \hline & & 248.80 \end{array}$$

$$F_1 = 280.45 \quad F_2 = 248.80$$

Readings of verniers for symmetric points are:—

$$\begin{array}{rcl} Z'_1 & = & 371.52 \\ & - & 76.10 \\ \hline & & 295.42 \end{array} \quad \begin{array}{rcl} Z'_2 & = & 184.17 \\ & + & 49.60 \\ \hline & & 233.77 \end{array}$$

$$S_1 = 295.42 \quad S_2 = 233.77$$

$$f = \text{mean of } F_2 - S_2 \text{ \& } S_1 - F_1 = \frac{15.03 + 14.97}{2}$$

$$f = 15.0 \text{ mm. ; } \mathfrak{F} = 66.6 \text{ dioptres.}$$

$$\kappa = 2(F_1 - F_2) - (S_1 - S_2)$$

$$= 2.05 \text{ mm.}$$

$$H_2 \text{ is at } 263.6 ; H_1 \text{ at } 265.65 \text{ of scale.}$$

A is plumbed at 262.65. Hence first principal point is 0.95 mm. within the front of the hemispherical surface.

(2) Substage Condenser (single lens), by Beck.—Flat upper face of lens taken as point of reference A.

$$\begin{aligned}
 A &= 251.8 \\
 Z_1 &= 356.32 ; \quad Z_2 = 196.5 \\
 &\quad -76.1 \qquad \qquad +49.6 \\
 \hline
 F_1 &= 280.22 \quad F_2 = 246.1 \\
 Z'_1 &= 370.54 \quad Z'_2 = 182.17 \\
 f &= \text{mean of } Z'_1 - Z_1 \text{ and } Z_2 - Z'_2 = 14.28 \text{ mm.} \\
 \mathfrak{f} &= 65.4 \text{ dioptries.} \\
 H_2 &= F_1 - f = 265.94 \\
 H_2 &= F_2 + f = 260.38 \\
 \kappa &= H_1 - H_2 = 5.56 \text{ mm.}
 \end{aligned}$$

(3) Coddington Lens, reputed 1 in. focal length.—Summit of one curved face taken as point of reference.

$$\begin{aligned}
 A &= 265.8 \\
 B &= 280.9 \\
 F_1 &= 299.3 ; \quad F_2 = 247.2 \\
 S_1 &= 325.6 ; \quad S_2 = 220.8 \\
 f &= (\text{mean of } S_1 - F_1 \text{ and } F_2 - S_2) = 26.35 \\
 \mathfrak{f} &= 37.95 \text{ dioptries.} \\
 H_1 &= F_1 - f = 272.95 \\
 H_2 &= F_2 + f = 273.55 \\
 \kappa &= H_1 - H_2 = -0.60 \text{ mm.}
 \end{aligned}$$

The Gauss points are crossed, and close together.

(4) Objective 1-in., by R. and J. Beck.

$$\begin{aligned}
 A &(\text{front of lens}) \text{ at } 248.2. \\
 F_1 &= 279.88 \\
 F_2 &= 241.98 \\
 S_1 &= 300.09 \\
 S_2 &= 221.75 \\
 f &= 20.22 \text{ mm.} \\
 \mathfrak{f} &= 49.46 \text{ dioptries.} \\
 H_1 &= 259.67 \\
 H_2 &= 262.21 \\
 \kappa &= H_1 - H_2 = -2.54 \text{ (Gauss points crossed).}
 \end{aligned}$$

(5) Objective 1/4 in., by R. and J. Beck.—Back focus too deep in tube to use ordinary micrometer; used a 1½-in. objective instead, as auxiliary lens, to explore focus.

$$\begin{aligned}
 A &(\text{front of lens}) \text{ at } 252.4 \\
 F_1 &= 274.88 \\
 F_2 &= 252.14 \\
 S_1 &= 281.20 \\
 S_2 &= 246.2 \\
 f &= 6.13 \text{ mm.} \\
 \mathfrak{f} &= 163.1 \text{ dioptries.} \\
 H_1 &= 268.75 \\
 H_2 &= 258.27 \\
 \kappa &= H_1 - H_2 = 10.48 \text{ mm.}
 \end{aligned}$$

(6) Objective reputed 16 mm., by Zeiss ("apochromatic").—(Used auxiliary lens as in preceding for back focus.)

$$A = 242$$

$$F_1 = 258.61$$

$$F_2 = 239.2$$

$$S_1 = 275.04$$

$$S_2 = 222.67$$

$$f = 16.43 \text{ mm.}$$

$$\mathcal{F} = 60.86 \text{ dioptries.}$$

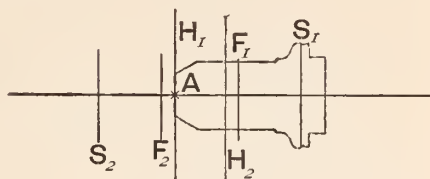
$$H_1 = 242.18$$

$$H_2 = 255.63$$

$$\kappa = -13.45 \text{ mm.}$$

(Gauss points crossed)

FIG. 17.



Zeiss's Objective.

(7) Objective reputed 8 mm., by Reichert.

$$A = 251.35$$

$$F_1 = 256.72$$

$$F_2 = 250.85$$

$$S_1 = 263.78$$

$$S_2 = 243.79$$

$$f = 7.06 \text{ mm.}$$

$$\mathcal{F} = 141.6 \text{ dioptries.}$$

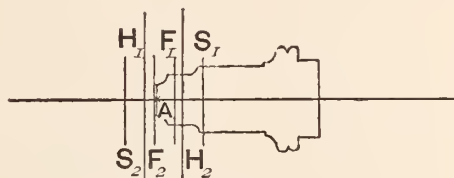
$$H_1 = 249.66$$

$$H_2 = 257.91$$

$$\kappa = -8.25 \text{ mm.}$$

(Gauss points crossed, and lie outside focal planes)

FIG. 18.



Reichert's Objective.

(8) Camera Lens (landscape), maker unknown.—A taken at front of mount. All measures plumb direct.

$$A = 233.9$$

$$F_1 = 417.8$$

$$F_2 = 151.0$$

$$S_1 = 547.7$$

$$S_2 = 20.45$$

$$f = 130.22 \text{ mm.}$$

$$\mathcal{F} = 7.68 \text{ dioptries.}$$

$$H_1 = 287.58$$

$$H_2 = 281.22$$

$$\kappa = 6.36 \text{ mm.}$$

(9) Aplanatic Condenser for Lantern, constructed by R. and J. Beek on Herschel's formula.—A taken at front of mount on concave side.

$$A = 237.5$$

$$F_1 = 365.5$$

$$F_2 = 193.3$$

$$S_1 = 435.7$$

$$S_2 = 121.8$$

$$f = 71.0 \text{ mm.}$$

$$\mathcal{F} = 14.8 \text{ dioptries.}$$

$$H_1 = 294.2$$

$$H_2 = 264.3$$

$$\kappa = 29.9 \text{ mm.}$$

(10) Camera Lens (small landscape), maker unknown.—A taken at rim of mount at front end.

$$\begin{aligned}
 A &= 247.2 \\
 F_1 &= 416.2 \\
 F_2 &= 136.7 \\
 S_1 &= 534.2 \\
 S_2 &= -1.3 \\
 f &= 138 \text{ mm.} \\
 \mathcal{F} &= 7.248 \text{ dioptries.} \\
 H_1 &= 278.2 \\
 H_2 &= 274.7 \\
 \kappa &= 3.5 \text{ mm.}
 \end{aligned}$$

No complete examination of any lens for rays of different colours has yet been made, but it has been found that lens No. 4, examined above for red light, gives with green light a different value for κ , though the lens is sensibly achromatic at the principal focus.

The most interesting results obtained so far are the facts that in so many compound lenses the Gauss points are crossed, the first point being beyond the second. And, in the case of one lens (No. 7), a Reichert's objective, the distance between these two points is found to exceed the distance between the two principal foci. It seems to be a necessity with all wide-angled compound lenses that the aberrations can only be reduced to a minimum by widely separating the constituent lenses, with the result that the optical centres of the combined lens are considerably displaced past one another.

Since the bulk of the foregoing investigations were carried out, the authorities of the Kew Observatory have decided upon undertaking the testing of camera lenses, and issuing certificates of merit. In this work they have had the benefit of the advice of Captain Abney, F.R.S., than whom no one is better able to advise as to what is desired for photographic purposes. This is an excellent beginning, but it is curious that in neither of the certificates issued is any information given as to the position of the optical centres, or their distance apart. The "differences in focal length" for red and violet rays are given, but whether this means difference in true focal length, or difference in position of focal plane, is not stated. What a photographer wants is not agreement in focal length, but in focal plane, which is a very different matter. Also in the "A" certificate issued from Kew, it is proposed to state the optical distortion at 25° from the axis, "including astigmatism." But whether this means that the test is to include one for cylindricity so as to give the direction of the axis of astigmatism in the focal plane, or whether this term is being misused to denote spherical aberration, does not appear. Certainly no really astigmatic lens could be tolerated for an instant in photography, as it would result in all vertical lines being out of focus when all horizontal lines were in focus, or some similar defect.

I notice in a recent most admirable article on photographic lenses, in 'Nature,' by Mr. A. Mallock, the term astigmatism is also used for the distance between the primary and secondary foci as produced by oblique rays. But this is not astigmatism at all, and has nothing to do with the

cylindricity of the lens, the defect which produces astigmatism. What Mr. Mallock applies this term to is spherical aberration pure and simple.

I pointed out in 1889, in my article in the 'Philosophical Magazine,' how the focal power of a lens is the product of a number depending only on the properties of the material into the sum of the two curvatures of its faces, or, in the case of thick lenses of a more complex quantity depending on the thickness of the lens as well as its curvatures. And in order to facilitate calculations I devised a special form of spherometer—the *dioptric spherometer*—(fig. 19) which measures the curvatures of the surfaces directly in dioptries. This was also constructed for me by Messrs. Nalder Bros. To apply this to any simple lens one merely takes

FIG. 19.

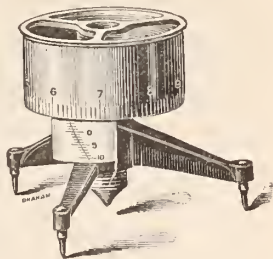
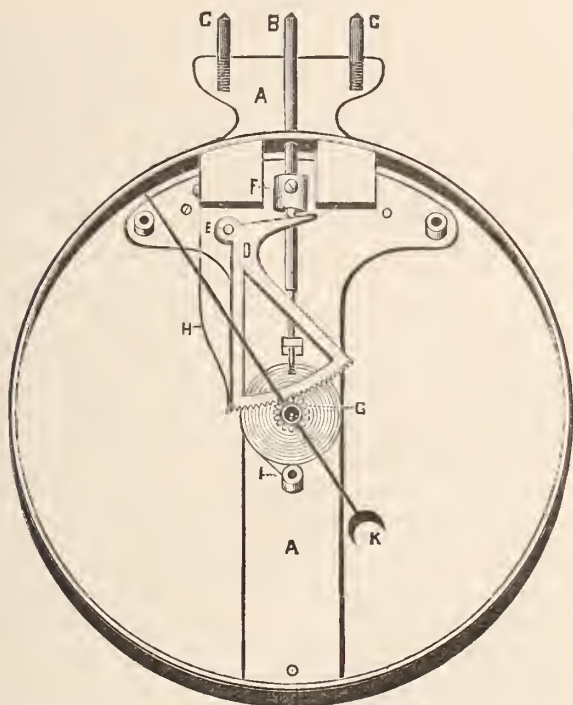


FIG. 20.



the two readings, adds them, and multiplies by a constant* which depends only on the material. For crown glass the constant is 0.54; and for flint glass it varies from 0.64 to 0.78 according to density.

* This is equal $\mu - 1$, where μ is the refractive index; or $(1 - h) \div h$, where h is the velocity-constant (relatively to air).

Since I published this, a still more handy device has been brought out by the Geneva Optical Company, of whom Messrs. Botwright and Grey, of Clerkenwell, are agents in this country. It is known as a 'Lens-measure,' and is depicted in fig. 20. It is the invention of Mr. Brayton, and consists of a simple form of spherometer with a multiplying-hand to read off the curvature on a dial. But the latter, instead of reading off the mere curvature of the surface, has the readings of its dimensions already multiplied by the proper constant for crown-glass, namely, 0.54; so that the dioptries of a lens are found simply by adding the reading of the two sides.

I will conclude by expressing my satisfaction that the British Association has seen its way to appoint a committee on the subject of the measurement of lenses. With Prof. Carey-Foster as chairman, and with Captain Abney, of South Kensington, and Mr. Whipple, of Kew, as members, such a committee ought to be able to effect some real progress in the spread of scientific methods, and so help forward the industry.

The paper was succeeded by a discussion.

Mr. G. M. WHIPPLE said he had been much gratified at hearing the reference which had been made to the work done at Kew in regard to lenses, for it ought to be better known that an attempt had been made in this country to create an optical laboratory. He was also very glad to know that the Technical Institute at Finsbury was doing similar work, and he felt sure that with the appliances they had there and the leisure at their disposal—not of Prof. Thompson, but of the senior students—many most interesting questions in optics might be dealt with, and he hoped solved, which could not be accomplished by those who had other duties allotted to them. The measurement of lenses for Microscopes had not come within the scope of their operations at Kew; their work was the examination of telescopes for the royal navy, binoculars, gun directors, a class of telescope not much known to the general public which had been recently brought out, besides smaller glasses used in the ordinary work of navigation. Again, the sextants which were employed by cadets must bear a certificate, and this had led to increased accuracy in make. There were also certain minor instruments examined, of which he need only mention one, which required a plane surface. The grinding of a plane glass surface was a somewhat difficult operation, and it had not been much required until recently, when they had been introduced and their use rendered compulsory for cadets as artificial horizons in working their sextants. This was a matter of economy to save the waste of mercury, which was somewhat considerable, when mercurial artificial horizons were employed. Plane surfaces of blackened glass were therefore introduced instead. These things had been going on for some time, but of late the Kew Committee had undertaken the examination of photographic lenses, and he must add to the names of the gentlemen who had been mentioned as laying down the lines on which the work should proceed, that of Major Darwin, formerly director of the photographic department of the School of Military Engineering. He had now retired from the Royal Engineers, and had thrown himself thoroughly into this question of testing photographic lenses. He seemed to have consulted all the authorities he could get at, and had made some very ingenious and beautiful pieces of apparatus for the purpose, amongst

them being a modification of Grubb's method of determining the focal length of lenses. It was much larger than Prof. Thompson's apparatus, being adapted to test lenses of 6 in. diameter and 30 in. focal length, and was about 5 ft. long and the same height. It proved very satisfactory in use. He regretted that the word astigmatism had remained on the prospectus and was kept in use, for it undoubtedly was wrong, but still it was a very convenient term to employ, and he did not know what could be substituted for it, and it was apparently understood by users of photographic lenses. There were other terms as regarded distortion and dispersion, which were not altogether correct, and should give place to a more accurate terminology. The point with regard to focal planes, which formed such an important feature in microscopic work, had not come before them in connection with photographic lenses, nor did they use it at all in testing telescopes and binoculars.

Mr. T. R. DALLMEYER said it was very gratifying to find that at last the efforts which were being made to obtain perfection in optical work were to be subjected to critical and scientific examination, which must result in really good work being appreciated. He was particularly interested in what he understood to be a new theory in treating light, as explained in the early part of the paper, and he wished Prof. Thompson had developed it further. One of the main things which opticians had to do was, after calculation, to do what he might describe as grinding a lens on paper, and this work, by ordinary processes, was very laborious. He imagined that if the process of which Prof. Thompson had only given the brilliant idea, were carried out with regard to the central pencils, that process of going through the mill in lens-grinding would be greatly facilitated. From the one or two hints which had been given, the method seemed to be simplicity itself. There were one or two other methods of obtaining the nodal points besides those which had been mentioned. He should like to ask if, in particular constructions—one of which he was deeply interested in—one of the nodal points was only radially outside the lens, would such an application be suited to the measurement of the lens as regarded its focus. He understood that, for taking long measurements, such an instrument would be hardly applicable, but that it was chiefly confined to the measurement of lenses where the nodal points were either contained in the instrument, or were very close to it.

Mr. CONRAD BECK said he also had been extremely interested in the paper, because he remembered his fearful struggles in endeavouring to work out lenses on the English system, and the delight with which he hailed the Gauss and the German system of reckoning both the signs and the principal planes. Those who had endeavoured practically to work out lenses on the ordinary system, as given in "Parkinson," and such books, would agree with him as to the enormous difficulties there were, which were entirely got rid of when the proper geometrical method of reckoning the signs, and the complete theory of the Gauss points were brought into work. As Mr. Whipple had said, the chief importance of the nodal points was with reference to microscopic work, and in that case there were some very awkward and difficult considerations. In old days, when the achromatic Microscope was first introduced, it was understood that some sort of reasonable magnifying scale should be

adopted, and an arbitrary scale was taken, in which the inch meant that it magnified a certain amount with a certain tube-length. But nobody knew where the tube-length was measured from. An American gentleman the other day published a paper in which he tabulated all the various tube-lengths as measured by various English and Continental manufacturers, and they varied most enormously. But, even supposing a definite tube-length to be taken, the difficulty still remained, because in order to get a magnifying power which should be in any way consistent with changed eye-pieces and object-glasses, it was necessary that low-power object-glasses should be mounted in enormously long tubes and high powers in very short tubes. When using a low power you then had to have it a long way from the object to begin with, and that difficulty was increased by mounting it in a tube 3 in. or 4 in. long, which in the case of a 5 in. would be simply preposterous. Then, again, supposing that, for the sake of scientific accuracy, such a plan were adopted,—what could be done in the use of a binocular Microscope? With the binocular Microscope it was essential to have the object-glass as near as possible to the binocular prism, whereas if lenses were mounted on the principle suggested, the low powers, which are the very powers used for binocular work, ought to be mounted a long way away from the tube of the Microscope. Until, however, this plan was adopted, no really true method of magnification could possibly be established. As a matter of fact opticians at present were making their low-power lenses very much higher in power than they ought to be in order to obtain this standard magnifying power which was adopted as an arbitrary scale. For instance, a modern 4-in. objective was nothing like 4 in.; it was nearer 3 in., because its nodal point was too far up the Microscope. It was put up to a much higher power to produce the same magnifying power in connection with the same eye-piece. This plan got over the difficulty tolerably, but when you changed the eye-piece you began to find that although with one particular eye-piece the magnifying scale was tolerably constant—and could be made absolutely constant—when you changed the eye-piece it did not affect different powers in the proper ratio, and the scale was thrown out. Mr. Whipple said the nodal points were not of so much importance in photographic and other optical lenses, and he was quite right in saying that their position was not of nearly so much importance, but it was extremely important some means should be adopted which eliminated the distances between the nodal points in measuring the focal length of optical instruments.

Prof. THOMPSON, in reply, said Zeiss's way of getting over the difficulty about tube-length was not quite as Mr. Beck had stated, because Zeiss distinctly attempted to regulate the depth to which the eye-pieces were to be plunged down, so that they should not overlap in the same way as in the old arbitrary scale. Whether he was successful in carrying that out with very low powers he could not say. In reply to Mr. Dallmeyer's question, he said that the present instrument would not measure lenses of more than 6 in. focal length. Mr. Whipple seemed to give no hope that the practical user of lenses would be content to change the misleading term astigmatism; but what were you to do if you came across a lens which had two defects, and both were called astigmatism? If they meant different things you must give

a different name to one of them, and he thought you ought to give a different name to the thing which was not astigmatism. Mr. Whipple and the Kew authorities ought to invent a name,* and then every one would be obliged to adopt it.

The CHAIRMAN, in proposing a vote of thanks to Prof. Thompson, said that this paper constituted a really important contribution to the knowledge of optical measurements. The instrument which had been shown and explained promised to be very useful indeed in the actual examination and specification of lenses. Hitherto there had been no accurate method which was easily applicable for finding the constant on which the action of any lens, and, still more, a combination of lenses, depended. In the ordinary treatment of the properties of lenses in this country, even in scientific text-books, one got no further than dealing with lenses which were not infinitely thin, but which were dealt with as though they were, and he hoped the paper would have a great effect in widening the ordinary optical discussions, and bringing the ordinary theory more nearly into accord with actual practical experience. As yet they had hardly got beyond Newton's optics. What Gauss introduced long ago, the idea of the virtual thickness of the lens, had scarcely been recognized in all its importance in this country, though it was of the utmost value in facilitating the statement of the properties of lenses. One small point in the paper which he thought of some importance, was the introduction of a term for what he believed had no name before, which was often referred to in foreign writings as the vertex, and which was here called the pole. Prof. Thompson had already made important contributions to optical theory; and he would refer especially to some papers of his which appeared two years ago in the 'Philosophical Magazine,' where he showed how very simply the properties of lenses could be expressed by the method he had hinted at in the beginning of this paper—by speaking of the curvature they impressed on the wave front of a beam of light passing through them. In those papers he had treated all the ordinary cases from that point of view with extreme simplicity and beauty, and he hoped this method would be adopted generally in the ordinary treatment of optics.

The Dioptrical Principles of the Microscope.†—Prof. G. Macloskie considers that the formulæ for calculating the path of light through a centered system of lenses is unnecessarily complex. He has tried a simple formula in Matthiessen's 'Dioptrik,' and finds that it can be extended to all cases, so that a single formula can be used to determine the focal lengths of lenses, doublets, objectives, eye-pieces, and of the entire optical system of a Microscope or telescope. For the refraction of a ray through a surface from a medium with index n_0 to another with index n_1 we have the two focal lengths

$$f_1 = \frac{\frac{n_0}{n_1} r}{\frac{n_0}{n_1} - 1} \qquad g_1 = \frac{\frac{n_1}{n_0} r}{\frac{n_1}{n_0} - 1}.$$

* The author has since suggested the term *aplantism* as a suitable name to denote this quantity.

† The Microscope, xi. (1891) pp. 209-15.

The formulæ giving the focal length of a lens are

$$f = \frac{f_1 f_2}{f_2 - g_1 + t_i} \quad \text{and} \quad g = -f = \frac{-g_1 g_2}{f_2 - g_1 + t_i};$$

where f_1, g_1 are the refractions for the first surface and f_2, g_2 those for the second, and t_i is the thickness of the lens. These focal lengths are measured from the principal planes. The author designates the three segments into which the lens is divided by these planes by the names *antepplane*, *interplane*, *postplane*, and the interval between the second principal plane of one lens and the first principal plane of the following lens by the term *transit*.

The formulæ for determining the principal planes are

$$a_1 (\text{antepplane}) = \frac{-f_1 t}{f_2 - g_1 + t}$$

$$a_2 (\text{postplane}) = \frac{-g_2 t}{f_2 - g_1 + t}.$$

The above formulæ give the focal lengths, &c., of a single lens, but by altering slightly the signification of the letters they also serve for the combination of two lenses to form a doublet. In this case f_1, f_2 , &c., denote the focal lengths of the individual lenses instead of those of the surface refractions, and t denotes the transit distance instead of the thickness of the lens. The same formulæ then serve for combining the doublets into an objective, and finally for finding the dimensions and focal lengths of an imaginary lens equivalent to the whole Microscope.

To illustrate the application of the formulæ the author takes the case of a Microscope composed of an objective consisting of three doublets and the ordinary Huyghenian eye-piece. Each of the doublets C, B, A consists of a plano-convex flint lens ($n = 1.6$) combined with a double convex crown lens ($n = 1.5$). The thickness of the three flint lenses is $1/2$, $2/3$, and $3/4$ mm., and that of the three crown lenses $1, 4/3$, and $3/2$ mm. respectively, with radii of curvature 1, 4, and 10. The front vertex of the second and third doublets coincides in each case with the second principal plane of the underlying doublet. The eye-piece consists of two convex-plane crown lenses, with convex side downwards. The lower one is 3 mm. thick, and has radius of curvature 40, while the upper is 2 mm. thick, with radius of curvature 30.

Taking as an example the case of the crown lens of the front doublet C, we have

$$f_1 = \frac{-r}{n-1} = \frac{-1}{1.5-1} = -2. \quad g_1 = \frac{nr}{n-1} = 3.$$

$$f_2 = -\frac{nr}{n-1} = -3. \quad g_2 = \frac{r}{n-1} = 2.$$

$$\therefore f_c = \frac{f_1 f_2}{f_2 - g_1 + t} = -\frac{6}{5}.$$

$$\text{Antepplane} = 2/5 \text{ and postplane} = -2/5.$$

Similarly, for the flint lens we have $f_f = 5/3$ with

Anteplane = $5/16$ and postplane = 0.

In the figure the principal planes of the flint lens are represented by $f_1 f_2$, those of the crown lens by $c_1 c_2$, and those for the whole doublet by $d_1 d_2$.

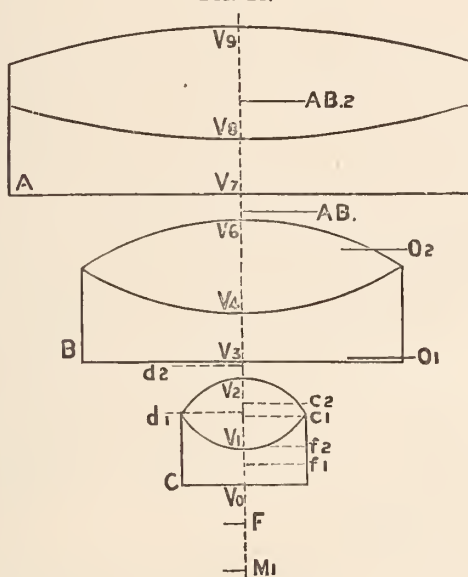
The transit distance for the two lenses $f_2 - c_1 = 2/5$.

Hence the first principal focal length of the doublet is

$$f = \frac{f_f f_c}{f_c - g_f + t} = \frac{30}{13}.$$

The same processes are applied to the other doublets A and B, which are then combined into a low power objective, whose principal planes have the positions marked $A B_1$ and $A B_2$. This is then combined

FIG. 21.



with the front doublet to form the total objective, whose principal planes are marked $O_1 O_2$ in the figure. Similarly, the equivalent lens for the eye-piece is determined, and finally the eye-piece is combined with the objective. The transit distance in the last case depends on the tube-length, and was 220.8432 for the Microscope used by the author. The total focal length was found to be $.623$, while the lower principal plane was 1.18 below the front vertex V_0 at the point M_1 in the figure, and the upper one at 6.794 above the eye-piece. The anterior focal length is positive, and its focus is represented by F .

The Effect of Curvature of the Cover-glass upon Micrometry.*—Dr. M. D. Ewell writes:—"Inasmuch as by far the greater number

* Proc. Amer. Soc. Micr., xii. (1891) pp. 79-83.

of observations with the Microscope are made upon objects under a cover-glass, it becomes an important subject of inquiry whether microscopic measurements are sensibly affected by the curvature of the covers. Especially is this true as to such experts as profess to be able to identify blood by the measurement of the red corpuscles. I have not been able to find in the literature any investigation of this subject, and having in the Cronin case been called as an expert with reference to the identification of blood by micrometric measurement of the red corpuscles, I made the observations herein recorded, not with a view to publication, but in order to be able to come to a correct conclusion as to one factor in that case.

In the comparison of long standards this question has no importance whatever, inasmuch as they are always uncovered; but inasmuch as most objectives in common use are corrected for covered objects, or are usually so used, the value of one division of the micrometer used with such objectives on covered objects must be determined from a micrometer having its lines covered either permanently or temporarily.

It is obvious that sensible curvature of a cover-glass interposed between the object and front of the objective must affect the amplification of the objective. If such curvature is spherical this effect will be symmetrical; if the curvature is irregular it must distort the object, so that the interval between two objects will appear to be different according to the orientation of the cover-glass.

Several methods are available for testing the curvature. It may be tested by viewing with a telescope the image of some regular object, such as a building reflected from the cover-glass. It may also be tested by accurately focusing a telescope upon some object, such as an artificial star, and then interposing the cover-glass to be tested between the object viewed and the objective of the telescope. If the cover is flat and if its sides are parallel, such interposition will have no effect upon the image other than very slightly to diminish the amount of light received from it. If the cover-glass is spherical it will change the focus of the telescope, which must be refocused in order to obtain a clear image of the object observed. If the cover-glass has irregular curves the image will also be distorted. If the cover-glass is prismatic the image will be displaced laterally.

A very much more sensitive method than either of the above is that by the observation of the Newton's rings, caused by placing the cover-glass upon a flat surface. For this purpose I obtained one of Mr. Brashear's justly celebrated flat test surfaces; but having found upon trial that the second method above described was sufficiently sensitive for my purpose, it was used exclusively in the observations hereinafter described. Tested by this method, I may state that nearly all the cover-glasses in common use possess either regular or irregular curvature. Tested by the method of Newton's rings, I am informed by Mr. Brashear that it is practically impossible to find one perfectly flat. I have myself examined and tested a large number furnished me by the courtesy of the Bausch & Lomb Optical Company and the Palmer Slide Company, as well as some purchased of Mr. Zeiss of Jena, and have found a very few that by the second method above described were sensibly flat. By far the greater number possessed quite sensible curvature.

My method of determining whether the curvature of the cover-glass sensibly affected micrometric measurements was carefully to measure the same space under identical conditions, except as to the cover-glass, and to compare the results. For this purpose a high-angled dry objective was employed, as being more likely to be affected by a variation in the cover-glass than a homogeneous immersion or low-angled objective. The cover-correction was made as perfect as possible and not changed thereafter.

The measurements were all made with a Bausch & Lomb first-class 1/6 objective (cover-correction = $0 + 3 + 1/2 + 2/10$), a Bulloch filar micrometer, a Smith's vertical illuminator, manufactured by Mr. W. H. Bulloch, and a Bulloch stand, 'Professional No. 2.'

The space measured was the second 1/100 mm. of 'Centimeter A,' counting from the first line of the 1/100 mm. band. The temporary covers, except as otherwise noted, were 16/100 mm. in thickness, and all except numbers 1, 7, and 9 were taken at random from covers purchased in the ordinary course of trade or furnished by the courtesy of the Bausch & Lomb Optical Company and the Palmer Slide Company. No. 1 was so nearly flat that its curvature, if any, could not be detected by the second telescopic test above described. Nos. 7 and 9 were covers ground and polished to order by Messrs. Bausch & Lomb, with the express purpose of making them as nearly flat as possible, but with the effect of making them more curved than covers usually are which have not been thus treated, experience showing that the covers are so easily warped that they cannot by ordinary methods be ground flat.

The measurements are recorded in terms of divisions of the micrometer of which 1 division = 0.0732μ . The number at the head of each series refers to the temporary cover used in the series.

October 6, 1889.

No. 1 (flat cover).		No. 4.	
	131.4 div.		131.7 div.
	131.2 "		3.9 "
	133.0 "		1.0 "
	132.0 "		2.9 "
	133.0 "		1.0 "
Mean:	132.1 "	Mean:	132.1 "
No. 2.		No. 5.	
	132.4 div.		131.9 div.
	132.5 "		1.0 "
	131.6 "		1.8 "
	130.5 "		1.2 "
	131.9 "		1.7 "
Mean:	131.8 "	Mean:	131.5 "
No. 3.		No. 6.	
	130.0 div.		131.7 div.
	3.3 "		1.7 "
	1.9 "		2.5 "
	0.7 "		2.4 "
	1.8 "		1.1 "
Mean:	131.5 "	Mean:	131.9 "

No. 7 (B. & L., ground and polished).

131.9 div.
 2.8 "
 4.0 "
 2.9 "
 1.0 "

Mean: 132.5 "

No. 8 (Zeiss).

131.4 div.
 1.6 "
 0.6 "
 1.1 "
 1.1 "

Mean: 131.2 "

No. 9 (B. & L., ground and polished).

132.2 div.
 3.4 "
 2.2 "
 2.4 "
 1.2 "

Mean: 132.3 "

No. 10 (No. 1 measured again).
(No. 1.)

132.6 div.
 3.0 "
 1.5 "
 4.0 "
 2.5 "

Mean: 132.7 "

No. 11 (cover 8/100 mm. in thickness,
and hence, there being no change of
the cover correction, bad definition).

132.2 div.
 1.8 "
 3.1 "
 2.5 "
 3.7 "

Mean: 132.7 "

No. 12 (No. 1 again).
(No. 1.)

133.0 div.
 132.3 "
 131.0 "
 131.0 "
 129.5 "
 132.5 "

Mean: 131.6 "

	Mean.	Difference from Mean.
1. Flat cover	132.1 div.	- 0.1 div.
2.	131.8 "	+ 0.2 "
3.	131.5 "	+ 0.5 "
4.	132.1 "	- 0.1 "
5.	131.5 "	+ 0.5 "
6.	131.9 "	+ 0.1 "
7. B. & L.	132.5 "	- 0.5 "
8. Zeiss	131.2 "	+ 0.8 "
9. B. & L.	132.3 "	- 0.3 "
10. No. 1, second time	132.7 "	- 0.7 "
11. Cover 8/100 mm.	132.7 "	- 0.7 "
12. No. 1, third time	131.6 "	+ 0.4 "
Mean of all 12 series ..	132.0 "	

Mean of all, excepting the series with the thin cover (No. 11),
 = 131.9 div.

Mean of the eight series excluding the three series of measurements
 with No. 1 and the series with the thin cover = 131.9 div.

Mean of the three series of measurements with No. 1, the flat cover
 = 131.1.

An inspection of the above measurements discloses the fact that the
 differences from the mean in the case of the three series in which the
 flat cover was used are as great as when other covers were used, and

that the mean of all the measurements using the flat cover is sensibly the same as with the other covers (some of which possessed a curvature quite sensible), the difference being only 0.02μ , which is too small to measure.

It was intended to make a much larger series of measurements, but the pressure of other work prevented.

The foregoing are, however, sufficient to warrant the conclusion (to which there may possibly, in the case of very bad covers, be some exceptions) that using good cover-glass, such as is furnished by reputable dealers in this country, the most, if not all, of which is manufactured by Chance, the influence of the curvature of such covers is practically *nil*.

This is not the conclusion to which the writer had come from *a priori* reasoning; but it is the only one warranted by such facts as have been observed. Further observations will be presented in a future paper."

Simple Method of Finding the Refractive Index of various Mounting Media.—Mr. E. M. Nelson communicates the following:—Provide two precisely similar equi-convex lenses, whose identical refractive index μ and radii r are known, and cement them together with the mounting medium whose refractive index has to be determined.

Now measure F the principal focus of the combination, then the refractive index of the mounting medium.

$$\mu' = 2\mu - 1 - \frac{r}{2F}.$$

It is convenient to make the radii of the equi-convex lenses 2 in. Then

$$\mu' = 2\mu - 1 - \frac{1}{F}.$$

Some examples might be of interest.

Let the refractive index μ of the two equi-convex lenses be $3/2$, and suppose that the combination has no focus, that is, that it behaves like a piece of plane glass, then

$$F = \infty, \quad \frac{1}{F} = 0,$$

and

$$\mu' = 2\mu - 1 = 2.0.$$

If the principal focus of the combination $F = +2$ then

$$\mu' = 2\mu - 1\frac{1}{2} = \frac{3}{2},$$

or the same as the equi-convex lenses.

But if the principal focus of the combination F is negative, it must be measured in the same way as a concave spectacle lens, viz. by neutralizing it by a positive lens of equal focus. If F is negative the sign before the fraction will be changed.

Example, let

$$F = -2.$$

Then

$$\mu' = 2\mu - 1 - \frac{1}{-2} = 2\mu - 1 + \frac{1}{2} = 2.5.$$

The above method gives a greater range of readings for indices varying from 2 to 2.5, and consequently more accurate results than the simpler one of filling up a plano-concave lens with the medium and covering it with a piece of plane glass. The formula for this latter plan being

$$\mu' = \mu + \frac{r}{F}.$$

The radius of the concave r might with advantage be made 2 in., then

$$\mu' = \mu + \frac{2}{F}.$$

If $\mu = \frac{3}{2}$, and $F = \infty$, $\mu' = \frac{3}{2}$; if $F = 4$, $\mu' = 2$; and if $F = 2$, $\mu' = 2.5$.

(6) Miscellaneous.

Experiments on the Diffracting Structure of Striated Muscle-fibre.*—Dr. O. Zoth has made a series of experiments on the diffraction of striated muscle-fibre similar to those first undertaken by Ranvier.

He supplements the simple method of observation employed by Ranvier with the method of Abbe, by which the diffraction spectra are observed in the Microscope, and uses the following arrangement. The source of light was at first a vertical slit, 10 mm. long and 1 mm. broad, in the screen of an argand burner, but later this was replaced by a zircon thread ignited by a Bunsen flame. Behind the Bunsen burner is a black background, and in front of it a black diaphragm with rectangular aperture, which serves to permit of the measurement of the bright line and to cut off extraneous light. The light from the source was reflected from a plane polished steel mirror, and a real image of the bright line was formed above the Abbe condenser. With the ordinary distance of 30–40 cm. between line and mirror the condenser (Zeiss 1.2 Ap.) throws an image of the line above the object. The Microscope, with low magnification (Zeiss A, eye-piece 2), is first adjusted on the object; the body-tube is then gradually raised until the image of the line is clearly defined, when on both sides of this direct image the diffraction spectra become simultaneously visible.

For the measurement of the distances of the individual spectra it was considered sufficient for the author's purpose to determine by means of an eye-piece micrometer the linear distances between the centre of the undiffracted image and the centre of the yellow in each spectrum.

The sartorius muscle of the frog was made the chief subject of experiment, and the numbers obtained by the above method in this case were compared with those resulting from similar observations on insect muscle. The arrangement employed was: Zeiss objective A, eye-piece III., with micrometer 5 mm. in 50 divisions, body-tube 155 cm., condenser 1.2 Ap., distance of source of light from the centre of the mirror 35 cm. The numbers obtained in divisions of the micro-

* S.B. Akad. Wiss. Wien, xcix. (1890) pp. 421–43.

meter were: for the frog's musele 27-32, for the musele of *Dyticus* 20-24, for that of *Hydrophilus* 13·5-16·5.

The musele in these experiments was prepared by Ranvier's method, which consisted in scraping it down on both sides with the scalpel. The thinnest of the lamellæ thus prepared might contain several superposed layers of fibre, so that it became of importance if possible to observe the diffraction effect of the cross striation of the individual fibres.

For the purpose of such experiments, teased preparations were made of musele which had been kept for a long time in 93 per cent. alcohol, and these were mounted in a mixture of equal parts of glycerin and water. The method of observation was the same as before, except that the Abbe condenser was lowered so far that the image of the source of light was projected beneath the plane of the object. Owing to the different thicknesses of the object-holders for the various preparations, it was necessary in each case to readjust so that the image of the source produced by the condenser should always be at the same distance beneath the plane of the object. This was effected by first adjusting the Microscope upon the object, then lowering the body-tube always by the same amount (102 divisions of the micrometer screw = 0·48 mm.), and finally raising or lowering the condenser until the image of the source became sharply defined. In the following table are given the results of measurements on different muscle-fibres.

Group.	No.	Object.	Measurements.	Limits.	Mean.
I. Grating on glass.	1	1 mm. in 100 divisions..	—	—	2
	2	500 " "	—	—	10
	3	1000 " "	—	—	20
II. Old alcohol-muscle; teased preparations in equal parts of glycerin and water.	4	<i>Hylobius abietis</i>	4	2	2
	5	<i>Hydrophilus piceus</i>	4	2·5-3·5	2·9
	6	<i>Scarabæus laticollis</i>	4	3	3
	7	<i>Vespa Crabro</i>	4	3·5-5	4·2
	8	<i>Melolontha vulgaris</i>	4	4·5-6	5
	9	<i>Dyticus marginalis</i>	4	6-8	7
	10	<i>Rana escul.</i> , stretched ..	8	6-8	7·1
	11	<i>Felis domestica</i>	4	10-12	11·1
	12	<i>Rana esculenta</i>	4	11·2-12	11·9

By comparing the numbers obtained for the muscle-fibres with those for the gratings, we have as mean distance of the striæ, since these are inversely proportional to the linear distances of the spectra, for the unstretched frog's musele $\mu 2 \cdot \frac{10}{11 \cdot 9} = 1 \cdot 68 \mu$, for the stretched muscle $\mu 2 \cdot \frac{10}{7 \cdot 1} = 2 \cdot 82 \mu$, for the muscle of *Hydrophilus* 7μ , for that of *Scarabæus* $6 \frac{2}{3} \mu$, and for that of *Hylobius* 10μ . These numbers, however, are based on the assumption that the muscle-fibres are similar to simple gratings with equal parallel and equidistant spaces. Such an assumption is approximately correct for the frog's musele in which the striæ Z (Rollett's notation) are only visible with great difficulty or not

at all; but it cannot be made for many other striated muscle-fibres, in which besides the striæ Q there are also recognizable, separated from Q by isotropic layers, the more strongly refractive finer striæ Z, and even another set N. The following table contains the results in microns for the three insect muscles, of the direct measurement of the distance of the striæ by the use of the eye-piece micrometer (Zeiss imm. 1/18, 1 division = 1.08μ).

			H.	ha.	hi.	Visible anisotropic striæ.
<i>Hydrophilus</i>	..	..	7.5	3.8	3.5	Q, Z.
<i>Scarabæus</i>	..	..	7	3.25	3.75	Q, Z.
<i>Hylobius</i>	..	..	13.5	6.5	7	Q, N, Z.

The approximate agreement of these results with those obtained by the diffraction phenomena would seem at first to warrant the idea that one of the cross striations, either Z (and N) or Q, is without influence on the total diffraction effect. Such a supposition, however, is not justifiable, and a great mistake would be made if it were attempted to draw conclusions from it in the direction of the Abbe diffraction theory; for the diffraction phenomena resulting from the complicated structure of insect muscle could hardly be expected to follow the laws of diffraction of a simple grating.

In a grating prepared for the author by Dr. Steeg of Homburg, the distances of the dark bands could be varied. This grating consists of

FIG. 22.



two superposed glass plates, each of which carries a fine division in 0.1 mm. The upper plate can be moved over the other by means of a micrometer screw, and can also be rotated so as to bring the lines in the two plates parallel. Fig. 22 shows the diffraction phenomena

corresponding to thirteen different arrangements of this grating. The black oblongs represent bright spectra, the hatched ones those with weakened intensity.

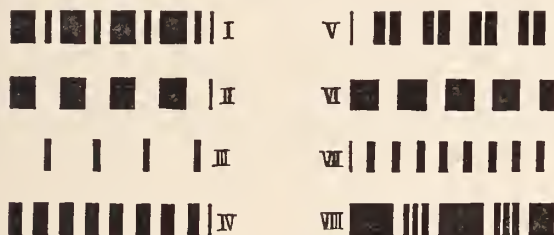
For the purpose of investigating to what extent the peculiar character of an abnormally diffracting grating has influence on the observed diffraction phenomena, eight photographic gratings on silver bromide gelatin plates were prepared. These gratings had the following dimensions in millimetres:—

Grating.	Width of clear space.	Width of opaque band.
I.	0·07	0·158, 0·035
II.	0·175	0·158
III.	0·298	0·035
IV.	0·084	0·084
V.	0·158, 0·035	0·07
VI.	0·14	0·193
VII.	0·114	0·053
VIII.	0·07, 0·035	0·28, 0·035

Their arrangement may be better understood from fig. 23, where they are represented under a magnification of twenty.

Grating I. is an attempt to represent the cross striation of a *Hydrophilus* magnified about 48 times. Nos. II. and III. are produced from No. I. by removal in the one case of the narrow, and in the other

FIG. 23.



of the broad dark bands. No. IV. is a simple grating, with spaces and bands the mean of those of No. I. No. V. is a negative of No. I. In No. VI. the width of the dark bands corresponds to the sum of the width of a broad and narrow band, and the width of a space to double the width of a space of grating I. In No. VII. the distance between the equally wide spaces is equal to the mean distance between the spaces in I. Lastly, grating VIII. is an attempt to represent a *Hylobius* muscle with striæ Q, N, and Z.

The diffraction phenomena produced by these gratings were observed in a dark room. The distance between the spectra was measured by means of a scale 10 cm. long suspended just above the aperture of the diaphragm in front of the zircon thread. This scale was illuminated from the side by an argand burner, and had white and black divisions alternately at distances of 1/4 cm. The gratings were placed at a distance of 150 cm. from the source of light, and the intervals between

the spectra observed by looking through them at the bright line were measured on the scale.

Grating I. gave 5 spectra on both sides at intervals of one scale division.

II. gave 8 spectra on both sides at intervals of one scale division.

III. 10 spectra visible, interval 1 scale division.

IV. 3 spectra, 2 scale divisions.

V. 7 spectra, $\frac{4}{5}$ scale division.

VI. 4 spectra, 1 scale division.

VII. 4 spectra, 2 scale divisions.

VIII. 7 spectra, $\frac{3}{5}$ scale division.

Grating on glass in 0.1 mm., 6 spectra, 3.5 scale divisions.

Thus, so far as the interval between the spectra is concerned, gratings II. and III. behave in precisely the same way as I. A difference between them, however, was noticed in the case of a fainter photographic proof in which the dark bands were not quite black: for grating I. the spectra 2 and 4 were seen to be considerably reduced in intensity, whereas for gratings II.-IV. no such effect was observed.

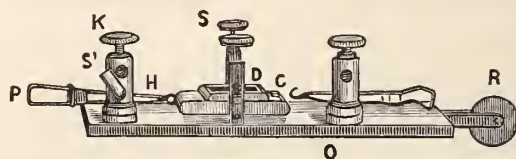
A muscle of *Hydrophilus* observed under the Microscope by use of a higher objective (Zeiss D) showed a similar reduction in the intensity of spectra 2 and 4.

The result of these experiments is to show that no definite conclusion as to their grating arrangement can be drawn from the diffraction phenomena obtained from the complicated striated muscle-fibre of insects. No consequences, therefore, as regards their resolution in the direction of the Abbe diffraction theory can be drawn from the observation of their diffraction effects.

The author has repeated Ranvier's experiments on the diffraction phenomena of living frog's muscle in different conditions of expansion and contraction, by using the Abbe method of observation.

Fig. 24 represents the object-holder which served for the preparation of the fresh sartorius or hyoglossus of *Rana esculenta*. In the

FIG. 24.



middle of a plate of vulcanite O is a rectangular opening, above which is cemented a glass plate G with rounded edges. On each side of this are two binding-screws for the wires of an induction coil. Through a hole in each of these binding screws passes a steel rod which carries at one end a small hook H and at the other a spring clip of platinum P. These rods are held firm by the screw S', but can be taken out and reversed if necessary. Over a small pulley at one end of the holder a thread attached to a scale-pan can be passed. This thread, after removal of the right steel rod, is fastened to the hook on the left and runs exactly above the plane

of the glass plate through the boring of the right binding-screw. Lastly a cover-glass D mounted in a metal frame is brought over the glass plate. The frame has on each side projecting pieces which fit into vertical grooves so that the cover-glass, either by its own weight of 1.45 gm. or by means of the two screws S, can be pressed down upon the preparation on the glass plate.

For observations on the unstretched muscle, the muscle is simply laid upon the glass plate, and covered by the cover-glass. For investigating the effect of stretching on the diffraction phenomena, the muscle is fastened to the hooks H, or preferably one end is fastened to the steel hook on the left, while the other is attached to the string which passes over the pulley to the scale-pan, in which different weights can be placed so as to vary the tension. For the observation of the diffraction phenomena during contraction and tetanus, the muscle is stretched in the same way. To conduct the current a fine wire connects the binding-screw through which the thread passes with the hook by which the thread is attached to the muscle. In these experiments the general arrangement for observing the spectra was the same as before.

The distances of the first spectrum from the undiffracted image in the case of the sartorius were as follows: unstretched, 35 divisions; weighted with 2 gm., 30 divisions; weighted with 10 gm., 25 divisions; for a hyoglossus at its maximum tension, 17 divisions.

Compression of the muscle has no marked influence on the distance of the spectra. Contraction of the muscle causes the spectra to approach one another. No displacement of the spectra occurs on exciting the muscle when at its maximum tension.

The late Mr. G. F. Dowdeswell, F.R.M.S.—The late Mr. Dowdeswell, who was some time a member of our Council, and for several years a constant attendant at our meetings, died in October last at the age of 56 years. His career was somewhat varied, for after an education at Eton and Magdalene College, Cambridge, he entered the army; he served through the Mutiny and the Chinese campaign of 1860-6. The later years of his life were devoted to Histology and Bacteriology, and he published on both subjects a number of important papers, partly in our Journal, in the Proceedings of the Royal Society, and elsewhere. Among the subjects in which he specially interested himself we may note the structure of spermatozoa and the "cholera bacillus." Mr. Dowdeswell was also a Fellow of the Linnean and Chemical Societies.

Good Advice!—The Editors—Professors E. D. Cope and J. S. Kingsley—of the 'American Naturalist' are often asked what journals of biology a college with limited funds should take. As may be supposed, they place their own journal first; "next in importance is the Journal of the Royal Microscopical Society." It is not for us to deny this.

* Amer. Natural., xxv. (1891) p. 895.

B. Technique.*

(1) Collecting Objects, including Culture Processes.

New Method of Studying the Development of Micro-organisms and the Mutability of their Characters and Properties.† — Dr. S. Délepine writes as follows:—"Those who have followed the discussions which have taken place between the partisans of the constancy (Koch, Zopf) and those of the mutability of the pathogenic bacteria (Davaïne, Naegeli, Pasteur, Buchner), know what stress has been placed on the impurity of cultivations, the pathogenic properties of which seemed to have altered. It is evident that one of the simplest ways to solve this vexed question would be, instead of studying the mixed products of the germination of a number of spores, to isolate one spore, and follow its development through all its stages, and the development of successive generations of organisms all derived from the same original spore and cultivated in various media. If it were possible to follow thus the history of one spore and its progeny, it would only be necessary, in order to obtain definite results, first to consider the complete series of morphological changes which occur, when the descendants of the same individual are cultivated severally in various media, then to connect certain physical and chemical alterations of the various media with stages of development, modified and unmodified, and finally to find how the properties of the organism at each developmental stage, are, or are not, modified by external circumstances. I had already attempted to carry out this plan by means of a dilution method, such as that used by Brefeld and others, since early in 1881, when working at the organisms of suppurating mucous membranes, a work which I gave up owing to the failure of the methods I was using then, and the special difficulties connected with the subjects. I was, however, already then able to satisfy myself that phenomena analogous to those of karyokinesis were of constant occurrence in multiplying bacteria and gave rise to many appearances which have been observed by others, though not explained fully yet.

About the middle of last year, whilst studying the development of certain pathogenic moulds and other parasites, I felt again the need of following closely the development of single organisms. I failed by plate and drop cultivations to obtain the results I wanted, partly owing to the effects of liquefaction of certain media, or of the mobility of others, partly also owing to the form assumed by drops. I was then led to adopt a new mode of cultivation which, although not perfect in many of its details, has yielded results which so far have been satisfactory, and some of which have been exhibited this year at a meeting of the Pathological Society (May 5th). The principle of the method is to inclose a thin layer of the nutrient media between two parallel plates, so as to force the organism to grow in definite directions. Owing to the effects of capillarity the most fluent nutrient media become, so to speak, fixed, provided evaporation be prevented, and they become as available as the

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, &c.; (6) Miscellaneous.

† Internat. Journ. Micr., iii. (1891) pp. 339-44. See Lancet, June 13th, 1891.

solidified ones. The method can of course be varied in many ways; but one of the simplest, and one of those which I have used with satisfactory results, is the following. At each end of a glass slide ($1\frac{1}{2}$ in. by 3 in.) a narrow slip of glass is fixed A A. This, as will be seen later on, is to act as a support. (The surface of the slide on which these slips are fixed will be called the upper one hereafter.) Three small drops of sealing-wax are dropped on the upper surface of the heated slide (any other thick cement, solid, and emitting no antiseptic vapours, at the temperature of the body, may be used instead of sealing-wax.) These drops will be used to support a cover-glass C, $1\frac{1}{4}$ in. in diameter, at a certain distance above the slide, and thereupon must form the apices of a triangle capable of being inscribed in the circumference of such a cover-glass. Before placing the drop of fluid on it, the slide must be thoroughly sterilized in the flame of a Bunsen burner, or otherwise. (The sealing-wax does not interfere with this process.) Then the slide is inverted or placed under a thoroughly sterilized plate. A cover-glass C, $1\frac{1}{4}$ in. in diameter, is sterilized also, and the surface which is to be next to the slide is carefully protected from the access of any germ or dust. On this surface a very small drop D of sterilized material may be placed, and this drop touched with a wire charged with a few organisms. A number of cover-glasses being prepared in this way, they may be examined over a sterilized plate with a pretty high power, inoculated surface downwards, and not in contact with the supporting slide, which must also be thoroughly sterilized, until a drop is found to contain the number of organisms wanted. Instead of a drop, a streak E E can be used, according to the nature of the organisms investigated. On the upper surface of the sterilized slide a drop of sterilized nutrient or other medium is deposited by means of a perfectly sterilized pipette. The size of the drop depends on the thickness one desires to give to the preparation or the surface one intends to cover. The diameter of the inclosed film should, in order to prevent contamination, never be more than $\frac{3}{4}$ in. when the cover is not more than $1\frac{1}{4}$ in. in diameter. (I often use larger covers and slides, but this in most cases has no advantage.) The centre of the side of such a drop may now be inoculated (in case the cover has not been previously inoculated). Then the cover is placed over the drop. It should be well supported by the three drops of sealing-wax, and should not at this stage flatten much the drop underneath. A heated rod is then applied successively over the three drops of sealing-wax, until the inoculated fluid has spread evenly over a certain surface under central parts of the cover; the preparation is then ready for the incubators. It has, however, to be kept in mind that, owing to the free access of air to the surface of the inoculated fluid, it is necessary to keep the preparation in a moist chamber. The extremely small size of these inoculated slides allows of a large number being packed in an extremely small space. Before incubating the preparation it is necessary to select out of the micro-organisms which have been sown into the fluid one or several, the position and relation of which are carefully noted.

For this purpose, divided cover-glasses or slides, or, as I prefer, a finder, can be used. I have in this way followed the development of bacteria and spores of the pathogenic *Pyrenomycetes* for days and weeks.

I have devised many improvements for regulating the thickness of the inclosed film, and making its thickness perfectly even, but these are not necessary to the success of the method, and their description would obscure its main object. Now it will appear to many that this is nothing else than a drop cultivation, and to others that it is a film or plate cultivation. It is all this, but I claim that it is something more; for by using an interlamellar film, as I feel inclined to call it, the free surface of the medium is limited to the space existing between the two glass lamellæ used, whilst in ordinary plate, film, or drop cultivations, the surface in contact with the air is very extensive. By the interlamellar method, a side view, so to speak, of the cultivation is obtained; by the drop method, a surface view. By the interlamellar method organisms placed at various distances from the free surface of the

FIG. 26.

FIG. 25.

FIG. 27.

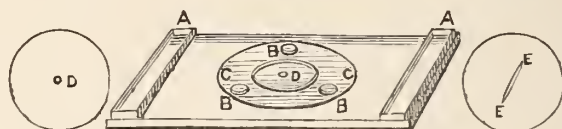


Fig. 25.—Slide with interlamellar film, ready for incubation. A A, Slide rests. B B, Drops of sealing-wax supporting the cover. C C, Cover-glass compressing a drop of nutrient material. D, Very small drop of gelatin or other material containing a few spores.

Fig. 26.—Cover-glass, with very small central drop inoculated.

Fig. 27.—Cover-glass, with a small central streak E E containing micro-organisms.

medium can be followed in their development step by step,* a thing utterly impossible in drop cultivation. By the interlamellar method it is possible to follow certain chemical changes occurring along a growing filament or colony extending in a direction which can always be determined;† this is impossible to the same extent in drop cultivations.

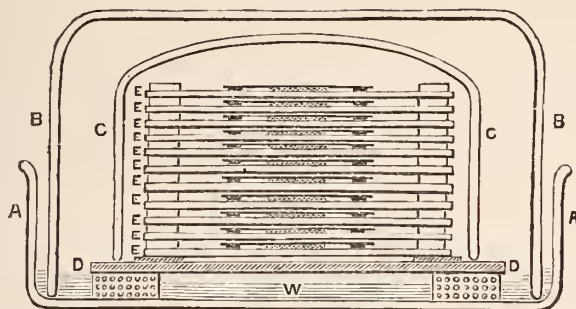
By the interlamellar method it is possible to follow for weeks the development of the same individual, or group of individuals, even in the midst of a fluid material; this cannot be done for any considerable length of time in drop cultivations; I feel therefore justified in claiming for the method some advantages. I wish, however, to

* In this way the branching of many bacilli can be demonstrated. This branching, which is supposed by most authorities not to exist among the Schizomycetes except in a spurious form, can by this method be easily demonstrated. I had, it is true, been led to believe in its existence from the study of organisms grown differently, but by this method branches may be seen to arise from definite filaments. Dr. Slater, who has kindly made many observations with me for the study of this point, has obtained results confirming entirely my views.

† By using media containing substances capable of forming insoluble compounds with the products of the metabolism of micro-organisms, the gradual formation of these metabolic products can be followed and demonstrated. Thus I have lately been able to demonstrate the formation of oxalic acid out of various substances, such as gelatin, starch, gum arabic, and possibly cellulose. I have been able to show that the formation of this acid begins only when growing filaments have free access to air—a fact of great significance in connection with Pasteur's teachings.

state clearly that it has disadvantages of a serious kind when the objects in view are not those which I have tried to explain, and therefore I do not offer this new method as anything more than a help to those who may try to solve some of the questions to which I have referred.

FIG. 28.



Diagrammatic representation of eleven interlamellar cultivations in a moist chamber, showing the disposition which I have adopted both for this method and other forms of film or plate cultivations. A, Outer basin, containing a thin layer of water (W) at the bottom. B, Covering basin, with a flat bottom, allowing a series of moist chambers to be piled one above the other in the incubator. C, Inner bell preventing condensed water falling upon the slide. D, Plates supported by pieces of cork. E's, Slides.

On some future occasion I hope to be able to give further details regarding the modifications which have been suggested to me by circumstances and the general nature of the results I have obtained."

Cultivation of Bacilli of Asiatic Cholera.*—Dr. Hueppe cultivated cholera bacilli in egg albumen, and by this method so virulent did the bacilli become that an injection of the culture into a guinea-pig produced toxic results in a few hours, and in a few days toxins were developed in sufficient quantities to kill the animal, while formerly forty days frequently elapsed before the death of the creature, even if it died at all. The active agent was globulin, which developed only in albumen and in no other substance. This toxin caused nephritis in most cases. The author believes the toxin of cholera to be a pepton. The aerobic bacilli of cholera were very resistant to hydrochloric acid, and thus adapted to pass through the stomach into the intestine.

Glass Cover-tube as Substitute for Cotton-wool Plug.†—As substitute for cotton-wool, and thereby avoiding many of the inconveniences of this system of plugging test-tubes, Dr. Schill advocates a simple device which he has adopted for two and a half years with satisfactory results. In principle it consists in covering one test-tube with another. The cover-tube is about two-fifths the length of the cultivation-tube, and both are made quite straight, and not lipped, so that they are easily slipped the one over the other, the interspace being about as thick as a

* International Congress of Hygiene and Demography, 1891. See *Lancet*, ii. (1891) p. 376.

† *Centralbl. f. Bakteriol. u. Parasitenk.*, x. (1891) pp. 657-9 (1 fig.).

sheet of paper. The author employs them in two sizes—one 16 cm. long by 15 mm. in diameter, the other 18 cm. by 25 mm.; the former for stroke and puncture cultivations, and for small quantities of fluid media; the larger size for potato cultivations, for large quantities of solid or fluid media, and for purifying agar.

For facility of sterilizing in dry or moist heat, for cultivations in any kind of media and with any kind of gaseous environment, the author states that this simple device gives very encouraging results, and obviates at the same time many of the inconveniences of cotton-wool.

Apparatus for filtering Gelatin.*—Dr. Schill points out that gelatin may be filtered much more rapidly than by the ordinary filter by means of a vessel the bottom of which is perforated by a number of holes—so many more filters, in fact. The bottom of the vessel is of course covered with filter-paper.

The simplest way to make the apparatus is to knock off the top of a preserve-tin or jam-pot, and make holes in the bottom with an awl or gimlet. The holes are made inwards. The bottom is then covered with filter-paper, the edge of which is made to lap up along the side of the vessel. The filter-paper is supported by a double layer of book-muslin, from which all grease has been carefully removed, and this is fixed round the filter by means of a rubber band.

For hastening the process of filtration, atmospheric pressure may be made use of. In this case the filter-vessel must have a top with a hole fitted with a caoutchouc stopper perforated for the passage of a glass tube. To the outside end of the tube is applied a funnel, while the lower end reaches very nearly to the bottom of the filter. Consequently as soon as a thin layer of gelatin forms at the bottom of the filter, the air above is compressed, and this accelerates the flow of the fluid. In other respects the apparatus is the same as the previous one. The filter apparatus may be made of wood or tin, but best, of course, of glass or porcelain.

Graduated Capillary Pipette for measuring very small quantities of fluid.†—Dr. G. Gabritschewsky has devised a pipette by which it is possible to remove a deposit from 0.001–0.1 cm. or any intermediate quantity of fluid. The instrument is made on the same principle as that used in the enumeration of red corpuscles, and fitted at the end with a rubber tube clipped by a screw-clamp. The pipette, the exact form of which is given in an accompanying illustration, is chiefly intended for estimating the number of bacteria in a fluid. The instrument is to be cleaned after each time of using with dry heat, alcohol, ether, and water.

(2) Preparing Objects.

Study of Development of Cephalopods.‡—Mr. S. Watase separated the blastoderm from ova, which he had artificially fertilized and kept alive, by killing the egg at any given stage of division by a mixture of sea-water, acetic and osmic acids, as recommended by the Hertwigs for their macerating fluid. The osmic acid may be reduced in quantity or

* Centralbl. f. Bakteriöl. u. Parasitenk., x. (1891) pp. 659–60 (2 figs.).

† Tom. cit., pp. 248–9 (1 fig.).

‡ Journal of Morphology, iv. (1891) pp. 249 & 50.

dispensed with. It was found most satisfactory to remove the ovum from the action of the reagent as soon as the translucent protoplasmic germ-disc turns whitish opaque, which takes place very quickly, and to complete the separation of the blastoderm in dilute glycerin. The separated blastoderm may afterwards be stained with dilute Schneider's acetic carmine, or with Ehrlich's hæmatoxylin, and then mounted in glycerin; or it may be left unstained, for most things can be satisfactorily made out without any staining, and by avoiding this unnecessary process of *technique* the risk of injuring or dislocating the blastoderm is greatly lessened. Treatment of living eggs with Perenyi's fluid for a few seconds is excellent for the surface study of cleavage; it turns the protoplasmic portion of the ovum opaque yellow, and brings out the cleavage furrows distinctly, while the rest of the egg remains translucent as before.

Mode of Investigating Bryozoa.*—Mr. C. B. Davenport found that the Gymnolœmata present many difficulties to finer technique; their chitinous covering is often very thick, and there is frequently, in addition, a calcareous skeleton. When the latter is present, picro-nitric acid mixed with sea-water is a fairly good fixing reagent; when it is absent, hot corrosive sublimate is the most serviceable. Extreme caution must be taken in transferring the objects through the grades of alcohol, so as to avoid the collapse of the ectocyst; the author made use of the chloroform-paraffin method of imbedding in order to make the transfers more gradual. The best staining agents were alcoholic dyes like Kleinenberg's hæmatoxylin and Mayer's cochineal, though Ehrlich's hæmatoxylin was often used with success.

Method for demonstrating Structure of Spinal Cord and Cerebellum.†—Prof. A. Van Gehuchten, from a series of observations made on the spinal cord and cerebellum, confirms the original statements of Ramón y Cajal, who in his researches followed the technique devised by Golgi with some slight modifications.

The spinal cord and cerebellum, in the embryonic, newly born, and adult conditions, of several kinds of mammals and also of the fowl, were used for the purposes of these observations.

The author's practice was to place small pieces of nervous tissue in a mixture of 3 per cent. bichromate of potash and of 1 per cent. osmic acid in the proportion of 4 parts bichromate to 1 part osmic acid. The pieces, several millimetres thick, usually remained in the mixture for two to two and a half days at the ordinary temperature, but fixation can be hastened by keeping them at a temperature of 35° to 40° for thirty to forty hours. On removal the pieces are rapidly washed in distilled water, and then immersed in the 3/4 per cent. nitrate of silver solution, whereby a precipitate of chromate of silver is deposited in the nervous tissue. The addition of one drop of formic acid to 100 ccm. of the silver nitrate solution considerably aids reduction, the precipitation commencing immediately on immersion of the pieces in the bath, wherein they remain for at least twenty-four hours, but a still longer stay is not harmful, provided light be carefully excluded.

* Bull. Mus. Comp. Zool., xxii. (1891) p. 3.

† La Cellule, vii. (1891) pp. 81-122 (4 pls., 55 figs.).

On removal from the silver solution the pieces are placed in 96 per cent. spirit for fifteen to twenty minutes, and then for a quarter of an hour in absolute alcohol. The next step is to soak them in a dilute solution of celloidin for a quarter of an hour, then fix them to a piece of cork, after which they are hardened in 70 per cent. spirit, so that the sections may be cut about an hour after being removed from the silver solution. The sections are next immersed successively in alcohol and creosote, cleared up in oil of turpentine, and mounted in xylol-dammar. The dammar should be dried as quickly as possible by keeping the preparations in an incubator at 40° for twenty-four hours.

Method for demonstrating Structure of the Cerebral Cortex.*—In his researches on the cerebral cortex, Prof. Ramón y Cajal used small mammals in the embryonic and recently-born conditions. The procedure adopted was the rapid method of Golgi. The author found that the most favourable period for obtaining a good colouring of the nervous elements was not the same for all the animals employed; for example, in mice the optimum varied from the 8th to the 25th or 30th day, while in the rabbit the favourable period was found to be from the 1st to the 15th day after birth. The time required for hardening in the osmic-bichromate mixture was two, three, to five days, in recently-born rabbits, guinea-pigs, and cats, but this is only a rough estimate, for the time required varies for each animal and for every stage of development. This caution holds good not only for the fixation but also for the colouring of the different constituents of nervous matter, some elements requiring a longer time than others.

In order to insure a certain result it was found necessary to always carry on the procedures at a constant temperature. In winter the author worked at a temperature of 25° to 26°, this being maintained by a stove with a thermo-regulator.

The size of the pieces to be hardened should not exceed half a centimetre to a volume of 25 to 30 cubic centimetres of the mixture.

Occasionally no reaction takes place or is very imperfect, owing to the proper period for impregnating having been exceeded. In this case a successful result may be sometimes obtained by reimmersing the preparations for another 24 or 36 hours in the silver solution.

When colouring the superficial elements of the brain, it is very important to prevent any deposit of chromate of silver crystals on the surface. This may be avoided by the devices suggested by Martinotti and by Schwald, and also by leaving the pia mater and arachnoid on the cortex, or by covering the cortex with a thin layer of the fresh blood of the animal.

The addition of one or two drops of a concentrated solution of chromic acid to the solution appears to aid the colouring of the col-lateral fibres. It is certainly advantageous in spinal cord, more especially if the vertebral column has to be cut together with the cord, since it helps to dissolve out the inorganic matter from the bone.

The author used the original mixtures for the chrom-osmic acid and silver solutions, not modifying them in any way, nor did he adopt

* *La Cellule*, vii. (1891) pp. 125-32 (3 pls., 19 figs.).

the suggestions of Greppin and Obregia in preserving the impregnated sections, for he has found that the chromate of silver deposit and the chloride of gold, while fixing the protoplasmic expansions and the large axis-cylinders, act very unfavourably on the delicate collateral branchlets, causing them sometimes to disappear altogether.

Permanent Preparations of Aleurone and its inclosed Substances.*

—Dr. F. Krasser recommends the following methods for the differentiation of the ground-substance, crystalloids, and globoids in aleurone grains. A very favourable object is *Ricinus communis*.

1. *Picrin-eosin*.—Sections are fixed with picric acid dissolved in absolute alcohol, and the excess removed by absolute or very concentrated alcohol, and are then stained by eosin dissolved in absolute alcohol, cleared by oil of cloves, and set up in Canada balsam dissolved in chloroform. The staining is accomplished in a very few minutes. The preparation shows the ground-substance dark-red, the crystalloid yellow with a sharp outline, the globoid nearly colourless or reddish.

2. *Picrin-nigrosin*.—The section is placed in a saturated solution of picric acid in absolute alcohol, in which nigrosin has been dissolved to saturation; the staining is continued until the ground-substance becomes blue. The preparation is then washed with absolute alcohol and placed for a very short time in oil of cloves, and set up in Canada balsam. The ground-substance is blue, the globoid colourless, the crystalloid yellow-green with a sharp outline.

Very good preparations of the crystalloids alone can be obtained by staining with eosin after first dissolving off the ground-substance and globoids by a very dilute aqueous solution of sodium phosphate.

“Microplyne” and “Microzete.”†—M. L. G. Chauveaud describes two appliances which he finds of great use in the preparation and examination of sections of vegetable tissues. The “microplyne” is a small glass funnel with a delicate perforated disc of platinum placed across the tube. On this disc is first of all placed a layer of powdered glass; then the sections of tissue which have been properly prepared, then another layer of powdered glass; and the staining reagent is then allowed to filter through the powdered glass on to the section; the excess filtering away through the lower layer of glass. The watch-glasses containing the stained sections are then placed in the “microzete,” a table illuminated from below by movable double black and white mirrors, and with a movable lens above by which to examine them.

(4) Staining and Injecting.

Some Methods of treating Nerve-tissues.‡—Dr. W. C. Krauss writes:—“The aims to be sought after in the study of microscopy are not alone those looking to the perfection of the instrument nor those which bear upon the selection of the specimen. The preparation of this specimen, and more especially the method of staining, is as important as the specimen itself. American microscopists are more intent upon the former; the European microscopists pay more attention to the latter.

* S.B. K. K. Zool.-Bot. Gesell. Wien, May 29, 1891. See Bot. Centralbl., xlviii. (1891) p. 282.

† Ann. Sci. Nat. (Bot.), xiv. (1891) pp. 16-24 (3 figs.).

‡ Proc. Amer. Soc. Micr., xii. (1891) pp. 116-9.

Careful study and experimentation with the different dyes have led to the compounding of stains which have enabled the Microscope to reveal many of the mysteries of histology and pathology. The introduction of the anilin dyes and their successful employment by Koch, led to the discovery of the bacillus of tuberculosis, although the existence of this organism had been prophesied by writers years before its discovery. Golgi's silver nitrate method has advanced our knowledge of the ganglion cells of the cortex of the brain, and perhaps at some day the mystery of their poles may be revealed through some simple method of staining. The importance, therefore, of the methods of staining is not to be overlooked or undervalued in the microscopical examination of tissues, and their successful employment may lead to the discovery of new facts and data of inestimable value in advancing the present status of our science.

Among some of the recent methods employed in neuro-histology and neuro-pathology, perhaps none are so important and satisfactory as the Weigert method and the Pal modification of this method. Both methods are restricted to the examination of nerve-tissues, more especially of the central nervous system, where the gradation between white and grey matter is distinct and prominent.

Both methods require hardening in Müller's fluid, or simply in a saturated solution of potassium bichromate. A recent writer in 'Neurologisches Centralblatt,' Dr. Minor, of Moscow, finds that if sections of the brain and cord are subjected to the action of the positive pole in the bichromate solution, hardening will take place in three, four, or five days. After dehydrating and decolorizing in alcohol for some days, the preparations are ready for the imbedding mass. I have always preferred celloidin for imbedding nerve-tissues, and find that it is an excellent agent. It is prepared by allowing several sheets of celloidin to dissolve in equal parts of sulphuric ether and 99 per cent. alcohol. The preparations to be imbedded are placed in 99 per cent. alcohol for 24 hours, transferred to equal parts of 99 per cent. alcohol and sulphuric ether for another 24 hours, then placed for 24 hours in the celloidin solution, fastened upon corks, and are then ready for cutting.

The sections being more or less delicate and very friable, it is necessary to protect them during their passage through the various stages of the process. For this purpose collodion, photoxylin, or dextrin may be used, the *modus operandi* being as follows:—Allow some of the mass to flow over a glass slide, so that a thin film remains; dry; then transfer the sections on to this prepared slide, and pour some of the mass over the sections, allowing all superfluous quantities to drip off. After a few moments the slide may be moistened in alcohol, when the sections imbedded in collodion can be removed and handled with impunity.

The Weigert method, first described by Prof. Weigert, of Frankfort on Main, in 'Fortschritte d. Medicin,' 1884, p. 190, and 1885, p. 236; also 'Zeitschrift f. Wissenschaftliche Microscopie,' 1885, p. 490, and 1886, p. 480, requires the sections to be placed in an aqueous-saturated solution of cuprum acetate diluted with an equal amount of water for 24 hours, in a brood oven, or 48 hours in the open air. They are then washed in 60 per cent. alcohol a few hours and placed in the Weigert

staining fluid :—0·75–1·0 parts hæmatoxylin ; 90 parts water ; 10 parts alcohol ; 1 part lithium carbonate.

At the end of 24 hours they may be removed, washed in water, and are then ready for the differentiating bath :—borax, 2 parts ; ferrocyanide of potash, 2·5 parts ; distilled water, 200 parts.

Some experience and great care are requisite in differentiating the sections, but with patience and judgment they can be developed with as much precision as the photographer displays in bringing out the light and shadows of a dry plate. The sections should be placed in the bath singly, so that each one may be removed as soon as it is differentiated. The length of time required is variable, depending upon the thickness of the sections. The general outlines of the white and grey matter should be known beforehand, and if pathological the seat of the lesion, so that as soon as the contour of the different regions becomes distinct, the sections may be immediately removed from the bath. Over-development destroys the sections, and hence as soon as they are removed from the bath they must be thoroughly washed in water for 12, 18, or 24 hours, to arrest all further development. They are then dehydrated in strong alcohol, cleared in Weigert's clearing mixture :—xylol, 3 parts ; carbolic acid, 1 part ; sulphate of copper, enough to cover the bottom of the bottle ; and mounted in balsam.

The grey matter, connective tissue, and vascular walls are stained light brown ; the ganglion cells, dark brown ; while the white matter takes on a blackish-blue or purplish-blue tint.

The Pal Method.—This method, which is merely a modification of the Weigert method, was described by Prof. Pal, of Vienna, in 'Wiener Medizinische Jahrbücher,' 1887, p. 589. The preliminary preparation of the sections is the same as with the Weigert method ; but with care and dexterity the imbedding in collodion may be dispensed with, as they are not rendered so friable and brittle. They are immediately placed in Weigert's staining fluid, to which has previously been added three to five drops of a saturated solution of lithium carbonate for every 10 ccm. of the stain used. After five or six hours they may be removed and carefully washed in water to which some of the carbonate of lithium solution has been added. They are now placed for ten or fifteen seconds in a 1/4 per cent. solution of the permanganate of potash, rinsed in 30 per cent. alcohol, and placed in the differentiating bath :—oxalic acid, 1 part ; sulphite of soda, 1 part ; distilled water, 200 parts.

The same hints regarding the differentiation of the sections as given under the Weigert method are applicable in this method. Should the sections be very slow in developing, they may be replaced in the permanganate of potash solution and the process continued as before. After they have been sufficiently differentiated they should be carefully washed in water for 24 hours, dehydrated in strong alcohol, cleared in Weigert's clearing mixture, and mounted in balsam.

The medullary nerve-fibres are stained light blue, the neuroglia, connective tissue, and vessel walls are rendered white or yellowish-white, while the ganglion cells become transparent. To stain these cells, after the development has been arrested by the water-bath, the sections should be placed in a picrocarmine stain for a short time, and the process completed in the ordinary way. To stain the nuclei, the

borax-carminé method must be employed as a double stain. These preparations, especially after accepting the double stain, are very pleasing to the eye, and more beautiful than the Weigert specimens. I have also found that they retain their stain much better than Weigert's. A serial section made over two years ago is in as good condition as ever.

The advantages which these two methods offer must be apparent to the most astute observer. To possess a method or methods which will sharply and clearly define for us the limits and boundaries of the white and grey matter of the brain and cord is a desideratum. The differentiation between the two renders the study of pathological lesions very facile, and to follow these changes cephalad or caudad becomes a very easy matter. More especially in tracing separate bundles, or even individual nerve-fibres, have these methods shown their superiority over all others. The Weigert method surpasses the Pal in this respect, being more reliable and trustworthy, and yet with the latter I have traced individual fibres in the pons and medulla with surprising accuracy. Another use to which these specimens may be put is in the study of the changes which the white and grey matter undergo in the transition between cord, medulla, pons, and crura. With the aid of a magic lantern the topography of these regions can be intelligibly demonstrated to a large class, whereas formerly these parts were almost totally ignored on account of their complex and complicated structure.

For the study of angio-pathological and gauglionic changes I prefer the carmine stains to the Pal and Weigert."

Reference Tables for Microscopical Work.*—In his fourth communication Prof. A. B. Aubert deals with anilin staining.

Alum eosin:—Eosin, 1 part; alum, 1 part; alcohol, 200 parts. Reagent for hæmoglobin. Specimens previously treated with osmic acid 1/2 per cent. for three minutes. Wash thoroughly before staining.

Anilin blue (water solution):—Anilin blue, 0·02 grm.; water, 25 ccm.; alcohol, 25 to 30 drops. Specimens hardened in alcohol.

Anilin black:—Anilin black, 0·5 grm.; alcohol, 99 ccm.; water, 1–2 ccm. Stains in a few minutes; for brain, &c.

Bismarck brown:—(1) Concentrated aqueous solution, warm, or weak alcoholic solution. (2) Bismarck brown, 1 part; water, 3000 to 5000 parts. For protoplasm, connective tissue, bacteria, living organisms, &c. Material to be hardened in alcohol or chromic acid; wash in absolute alcohol. Mount in glycerin or balsam.

Borax methylin blue:—Concentrated aqueous solution of blue, 24 vols.; borax solution, 5 per cent., 16 vols.; water, 40 vols. Dissolve, filter after 24 hours.

Chinolin blue:—Aqueous solution, 1–100,000 to 1–500,000. For living organisms (water analysis), &c.

Dahlia or Hoffman's violet:—Glacial acetic acid, 12·5 ccm.; absolute alcohol, 50 ccm.; water, 100 ccm.; dahlia nearly to saturation. For axis-cylinder of nerves, protoplasm, nucleus. Stains in 12 hours or less.

Eosin:—Water solution, or water solution and one-third of alcohol; or eosin, 1 part; water, 1000 to 1500 parts. For epithelium, muscle,

* The Microscope, xi. (1891) pp. 270–2.

axis-cylinder, amyloid degeneration, nucleus, &c. Stains in $1\frac{1}{2}$ to 1 minute.

Gentian violet:—Filtered 3 per cent. anilin solution in water; concentrated gentian violet solution in alcohol; or gentian violet, 2.00; ammonia, 0.5; absolute alcohol, 10. For bacteria, &c. At ordinary temperature stains in about 24 hours; 1 hour at 50° C. Treat objects with 30 per cent. hydrochloric acid, dehydrate in absolute alcohol, clear in oil of cloves, mount in balsam.

Iodine green:—Iodine green, 0.1 part; water or alcohol, 35 parts. Stains in a moment. Mount in balsam.

Fuchsin (rosanilin):—Fuchsin, 0.25 gm.; alcohol, 20 ccm.; water, 20 ccm. For nucleus, protoplasm, axis-cylinder, elastic tissue, retina, &c.; after staining, treat with alcohol.

Fuchsin (acid):—Concentrated solution in water. For nervous system. Sections hardened in chromic salts. Keep in stain one hour, wash with water, put into alcoholic solution of potash (potash, 1 gm.; alcohol, 100 ccm.; filter after 24 hours; use 10 ccm. diluted with 100 ccm. of alcohol); wash in water, dehydrate in alcohol (saturated with salt), mount in balsam.

Methylin blue:—(1) Erlich's concentrated water solution. (2) Koch's concentrated alcoholic solution: methyl blue, 10; caustic potash (10 per cent. 0.2; water 200). 1 and 2 for bacteria, cover-glass preparations; stains in $1\frac{1}{2}$ to 24 hours; wash in water, dry, mount in balsam. For tubercle bacillus; after staining in blue, transfer cover to concentrated solution of vesuvium (15 minutes), wash well in water, dehydrate in alcohol, clear in oil of cloves (micrococcus brown, bacillus blue.)

Methyl violet:—Methyl violet concentrated alcoholic solution, 11 ccm.; absolute alcohol, 10 ccm.; anilin water, 100 ccm. For bacteria, &c.; cover-glass preparations; stains in 24 hours; put cover for a few seconds in nitric acid and 3 parts water; wash with alcohol; stain with diluted vesuvium solution for a few minutes, wash in 60 per cent. alcohol, dehydrate in absolute alcohol, clear in oil of cedar, mount in balsam.

Methyl green: Water solution, $2\frac{1}{2}$ per cent. Nucleus, nerves, amyloid substance (degenerated tissue violet, normal green.) Stain in 24 hours.

Safranin:—(1) Safranin, 1 part; absolute alcohol, 100 parts; water, 200 parts. (2) Water, 1 part; alcohol, 1 part; safranin, as much as will dissolve. For nucleus; washed section stains in a few minutes; wash and dehydrate in absolute alcohol, mount in dammar or balsam. Water solution (1-1200) for bone development (bone, connective tissue, red; cartilage, yellow). Wash with water slightly acid with acetic acid.

(5) Mounting, including Slides, Preservative Fluids, &c.

Balsam Mounting.*—Miss V. A. Latham writes:—"In reading through the January number of 'The Microscope' I noticed the article on mounting. Cajepot oil is not new to me, as I have used it for several years, also oil of bergamot and several other oils; the last which I am now working on is terpenol or terbenol (Merck). The reason I first

* The Microscope, xi. (1891) pp. 281-3.

tried the oil of cajeput was the difficulty to mount neatly and evenly sections of human skin and tracheæ, for they curl up when placed in alcohol. This oil is better than clove oil for this purpose, but unfortunately alcohol has to be used, though the process is simplified by using it diluted. I hardly know of the specimens for which I have been compelled to use absolute alcohol, the ordinary spirit being sufficient. In England where methylated spirit is the chief dehydrator used on account of cheapness, then you may require to use absolute alcohol. The only cases in which I have used the last have been where I was making cover-glass specimens of bacteria, and was in a hurry for them to dry so that I could mount at once. Neither is it, I believe, used in the University of Michigan in the histological department. I find my mounts perfect, even those stained with anilins after some four years, and in a paper written in one of the journals of microscopy I casually mentioned it with some other clarifying agents. Turpentine and creosote are used by many to get over the difficulty of strong alcohol; these are very good, but personally I object to the penetrating odours. I would like to say that I think a great deal of difficulty is made over mounting in balsam, which in reality never or seldom exists. True, each method is not nearly so difficult on practically demonstrating as by reading. I give you the method I have always employed for myself and also for teaching, with success so far. Have a mounting card made so that you can use it to centre the slip. In the centre of the slide place a medium sized drop (the second which falls off the rod is about the size); carefully spread the balsam over the surface not quite to the edge of the cover (when it may have been placed in position). Lift the object from the clove oil, drain off most of the oil, except in such sections as lung, brain, &c., and transfer it to the slide in such a way that it is in the centre when mounted, and do not draw the lifter beyond the ring, or the medium runs a little outside the cover and makes an untidy mount. See that the sections have no folds, then take a clean cover-glass in the forceps, and near the edge of it let fall a drop of balsam, invert the cover, and place the point of a needle on the slip at about the place where the edge of the cover is to be when mounted; place the edge of the cover-glass against the needle and gently lower it till the drops meet and flow evenly; when the balsam gets to about the middle of the specimen, slowly draw away the forceps almost parallel to the slip and the cover is then in place, with few, if any, air-bubbles under it. Do not press down the cover with a needle or weight, for unless you have a quantity of superfluous balsam it is not necessary; put the slip away in a warm place in a tray or cabinet, perfectly flat, and in drying the balsam contracts and draws down the cover to the specimen. I often ring slides at once with Hollis's glue, even sending them by post 200 to 500 miles without the least harm. The two essentials are to learn the amount and thinness of the balsam, and not to leave too much clove oil on the lifter. Drying of objects in ovens, &c., seems to me a nuisance, except in cases of mounts without pressure, and even here I do not advocate it. The formula that I use for balsam may be useful, as it is colourless when mounted and easily made; otherwise the Palmer Slide Company's balsam is the whitest that I have bought of late years, and is a quick

drying medium, more so than the one I use. In fact I am anxious to find some solvent which will evaporate faster, and yet, if possible, at the same time, to avoid much contraction. Obtain a white sample of balsam in liquid form, and take by weight in all cases, in a wide-mouthed bottle, balsam, 3 oz.; turpentine, 1 oz.; chloroform (pure), 1 oz.; gently turn the bottle several times to mix well, and let it stand till free from air-bubbles and is thoroughly mixed. Pour out a small quantity at a time in a one dram bottle, and keep it covered with a cork, with a glass rod drawn to a point passed through it, or take a piece of glass rod and heat till soft, and press the two ends together so as to produce a flange. It is then easily wiped and cleaned with a rag moistened in turpentine. Care is taken to lower the cover very slowly. As a question, may I ask if any one who has been to Europe and returned here with specimens, has noticed how the climate causes great shrinkage to balsam mounts? As an instance, I have mounts of Cole's studies, and special mounts of his, and I find now that the zinc white has let air pass through and ruined the mounts, in many cases I have had to remount them. I may say here that I am not in favour of the usual white zinc cement, and recommend either brown varnish (Ward's, Manchester, England), or Hollis's glue. The last is the best, for it may be used with immersion lenses, and it renders ringing unnecessary afterwards, which is a bugbear if you should be in a hurry to examine a specimen, which is often the case in medical work."

Mounting Arranged Slides.*—Mr. G. H. Bryan remarks:—"I have recently discovered another use for the 'pressureless mounting clips' which I described in the 'Journal of Microscopy' for Jan. 1890. I find, namely, that by their use it is possible to mount slides containing an arranged group of various objects, such as several plant sections or parts of an insect, with great ease. To do this, the objects are placed as nearly as possible in the required position in a drop of liquid balsam. On putting down the cover, it will generally happen that, even with the utmost care, some of the objects will become displaced. Let the cover be now fixed between the jaws of two of my "pressureless clips." Then, by using several badger-hairs or bristles mounted in handles, and of sufficient length to be pushed right under the cover, the objects can be moved about in the balsam and brought into any required positions.

If the specimens again become displaced during the process of hardening the balsam, the slide may be warmed and the objects pushed again by means of a hair thrust underneath the cover into the softened balsam."

Simple Method of fixing Paraffin Sections to the Slide.†—Dr. G. Lovell Gulland writes:—"In Dr. Gaskell's interesting paper 'On the Origin of Vertebrates from a Crustacean-like Ancestor,' ‡ he describes a method (on p. 382) by which he succeeded in overcoming the folding of sections of the cranium of *Ammocoetes*. It consists in floating the series of sections on the surface of warm water, which flattens them, and

* Internat. Journ. Micr. and Nat. Sci., iii. (1891) p. 328.

† Journ. Anat. and Physiol., xxvi. (1891) pp. 56-60.

‡ Quart. Journ. Micr. Sci., xxxi. (1890).

then transferring them to the slide, which has previously been coated with albumen and glycerin. The sections are then dried by pressuro between blotting-paper, the wax is melted, removed by xylol, and the sections are then mounted in Canada balsam.

For some time before Dr. Gaskell published this method I had been using it, and had experimented with several modifications of it; one of these has been so successful in my hands, and in those of others to whom I have communicated it in this laboratory and other laboratories in Edinburgh, that I am desirous that it should become more widely known.

In using albumen and glycerin as a fixative, according to Meyer's method, which is, I suppose, the way in which Dr. Gaskell employs them, I have met with objections which made me wish to omit that part of the process. These difficulties are:—That it is not always easy to get the layer of albumen and glycerin of equal thickness all over the slide, so that the sections do not lie quite flat; that patches of coagulated albumen sometimes retain stains, especially some of the anilins, in a disturbing manner, and this inconvenience, I am told, is specially felt in microphotography; that in manipulating sections on the slide, solutions of pierie acid, moderately strong alkaline solutions, and some other fluids cannot be used, as they loosen the adhesion of the section to the slide. Further, I have found, in using Dr. Gaskell's method, that if a very large number of sections are to be mounted on one slide, the fixative is apt to be washed off; and if one trusts to the fixative afterwards, and proceeds in the usual way as described by him, some of the sections may be lost. The method I use is the following:—

The piece of tissue is imbedded in paraffin in the usual way, and I will suppose that a complete series of sections is desired, and is to be cut with the Cambridge rocking microtome. The paraffin block containing the tissue must be trimmed very carefully, care being taken to see that the surface meeting the razor is exactly parallel to the opposite surface, and that the block is exactly rectangular. A thin layer of soft paraffin is then applied to the surface meeting the razor and to the opposite surface—this is best done by dipping these surfaces into the melted soft paraffin—and when this has become firm the surfaces are again trimmed square. The reason for this very special care is that any curve in the ribbon, produced by neglect of this precaution, is accentuated by the flattening out of the sections, and though in mounting several ribbons on one slide a slight curve does not matter, and can, indeed, be corrected by folding up the soft paraffin between the sections, a sharper curve of course interferes with the regular disposition of the series. When all the sections required have been cut, the ribbon must be divided with a sharp knife into lengths corresponding to that of the slide in use. A very convenient size is a slide of 4 by 2 in. with a cover-glass of 3 by $1\frac{1}{2}$ in. These ribbons are then to be seized at one end with forceps, and the other end is gently lowered on to the surface of the warm water, and as the sections flatten out they will be found to move along the surface of the water, so that more and more of the ribbon can be lowered. It is not so satisfactory to hold both ends of the ribbon and lower the middle first. When the flattening is complete, the slide, carefully cleaned, is immersed in the water, the ribbon is floated

into its position on the slide with a stiff brush, and the process is repeated with one ribbon after another until the slide is full. With a little practice one soon learns how to bring the rows close together so that no space is wasted. The slide is then set up on end to allow the superfluous water to drain off.

The best dish for carrying out this process is, perhaps, a flat glass dish standing on a dark table, as the manipulation is more easily accomplished when the white paraffin is thus thrown up in relief. The temperature of the water is of course important, but as different workers use paraffins of varying hardness, no absolute rule can be laid down. It should be comfortably warm to the hand, but never so warm as to melt the soft paraffin holding the sections together. Short of this, however, the warmer the water the more rapidly and completely are the sections flattened.

So far the sections are simply lying loose upon the slide, and they have yet to be fixed to it. This is done by evaporating the water from the surface of the slide. The evaporation might be carried out in many ways, but I shall best explain it by describing my own practice. I almost invariably use paraffin for imbedding whose melting-point is 52° C., and the imbedding oven, an ordinary copper one, is therefore kept at about 54° C. or 55° C. The slides, after the water has drained off as much as possible, are placed on the top of the oven, where the temperature is probably a little under 50° C., and where, consequently, the paraffin of the sections is not melted, though the water rapidly evaporates. The slides are kept there, with a cardboard cover over them to keep off dust, until the evaporation is complete, and the sections have adhered to the slide. The time required for this varies, as I shall show immediately; but the important point is that the paraffin must never be melted until the last trace of water has disappeared from the slide. If this premature melting happens by any accident, the sections are certain to peel off later. When the water has evaporated completely, the opacity of the sections disappears, they become much more transparent, and they look dry. A very few experiments enable one to be sure of the point when slides are safe. Of course when the paraffin used for imbedding is of a lower melting-point than 52° C., the temperature for evaporation must also be lower; and when the oven is regulated as above, this can be managed by putting a few thicknesses of paper under the slide.

When the fixation is complete, the paraffin is melted by putting the slide inside the oven for a little, and is then washed off with turpentine or xylol; and, if the piece of tissue has been stained *en bloc*, the sections can be mounted at once in balsam.

One of the great advantages of this method is the perfect ease and safety with which it allows sections on the slide to be manipulated, so that the most various stains and reagents can be applied successively to a slide, e. g. the complicated processes used to demonstrate bacteria in the tissues can be applied, with the certainty, moreover, that there is nothing on the slide to be stained which was not in the section.

The time required for complete fixation varies in dependence on several circumstances, but of these the most important are the thoroughness with which the superfluous water has been drained off the slide, and

the thickness of the sections. For instance, sections cut with five teeth of the rocking microtome require generally about an hour to dry in the way I have described; those cut with ten teeth perhaps three hours; while those cut with fifteen teeth take six hours, or even longer. This scale is only approximate, and it may be said, generally speaking, that the longer the slide is allowed to dry the better will be the fixation, and, of course, no harm is done to the section by leaving it for an indefinite time in paraffin, so long as the paraffin is not melted.

Of course a single section is to be mounted in the same way as a series, and it will be found that where it is desirable to examine a few sections with as little delay as possible, warm methylated spirit, or even absolute alcohol, evaporate more rapidly than water, while the fixation is as perfect with them, and the method of use exactly the same, as with the less volatile liquid. For obvious reasons these fluids are not likely to be used frequently with long series of sections."

(6) Miscellaneous.

Detection of Adulteration in Linseed and in Linseed-oil Cake.*—M. J. Van den Berghe finds that linseed oil-cake is adulterated in commerce by a large number of foreign substances, among the most frequent being colza, mustard of various kinds, hempseed, *Ricinus*, *Arachis*, poppy, &c. For detecting these adulterations he recommends treating the linseed successively with sulphuric acid (2·5 per cent.), soda (2·5 per cent.), alcohol, and ether, and then digesting for some hours in the cold with a concentrated solution of calcium chloride. This makes both the pericarps and the testa of seeds so transparent that the distinctive characters of the various kinds can be readily recognized under the Microscope. The nutritive reserve-substances of linseed being chiefly aleurone-grains and drops of oil, iodine solution should not give the blue reaction when the oil-cake is pure.

* Tourteaux et farines de lin (6 pls. and 24 microphot.). See Bull. Soc. Belg. Micr., 1891, p. 160.

PROCEEDINGS OF THE SOCIETY .. .. .	165

MEETING OF 16TH DECEMBER, 1891, AT 20, HANOVER SQUARE, W.,
THE PRESIDENT (DR. R. BRAITHWAITE, F.L.S.) IN THE CHAIR.

The President said they were unfortunately left on that occasion without officers; the Fellows would learn with regret that their Secretary, Prof. Bell, and their Treasurer, Mr. Frank Crisp, were laid aside through illness, and Dr. Dallinger was unavoidably absent from an engagement elsewhere; under these circumstances Prof. J. W. Groves had kindly undertaken to act as Secretary for the evening; he would, therefore, call upon him to read the minutes of their last meeting.

The Minutes of the Special and Ordinary Meetings of 18th Nov. last were read and confirmed, and were signed by the President.

Mr. J. M. Allen called attention to the statement in the minutes of the special meeting as to the registration of the Society under the Friendly Societies Act. He believed that it would be more strictly correct to give the exact title of the Act under which they proposed to register; this was not really what was generally known as the Friendly Societies Act, but another Act of Victoria, which he thought was entitled the Scientific Societies Act.

The President said they would take note of the correction and have the suggested alteration inserted in the minutes, after having verified the proper title.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the Donors.

	From
Deby, J., Analysis of the Diatomaceous genus <i>Campylodiscus</i> , pp. 96, 15 pls. (8vo, London, 1891)	The Author.
Sternberg, G. M., Report on the Etiology and Prevention of Yellow Fever, pp. 271, 21 pls., text illust. (8vo, Washington, 1891)	U.S. Government.

Dr. R. G. Hebb called attention to the book from Dr. Sternberg which was one of the official reports of the United States Government. Dr. Sternberg was sent by the Government to Havana during an outbreak there of the yellow fever, in order to ascertain, if possible, the specific cause of the disease, and also the value of the system of inoculation then being tried as a preventive. Dr. Sternberg failed alike in finding the cause of the yellow fever, or the value of the inoculation. The book was rather a clinical one, in which the author gave a large number of plates showing a variety of micro-organisms found in Havana, but not the bacillus of yellow fever, though there was one called *Bacillus x* which Dr. Sternberg affected a little.

Mr. E. M. Nelson read a brief obituary notice of the late Mr. William Tarn, whose death at a comparatively early age had recently occurred. Being a silent member, it was not generally known that, owing to his knowledge of science and his skill in manipulation, microscopy had sustained a distinct loss.

Mr. T. H. Powell said he could thoroughly endorse all that Mr. Nelson had said as to the abilities of Mr. Tarn.

Mr. Nelson said that when calling attention to a drawing at the last meeting as being made with an apochromatic giving a magnifying power of $\times 850$, he had omitted to say that the objective used was one of 1/12 in. by Powell, which had proved to be a remarkably fine glass, free from colour and showing a great speed in photography. It was furnished with a correction collar, and had also the further merit of being the cheapest apochromatic yet produced.

Mr. H. Bernard exhibited and described a new form of mechanical stage for use with the Microscope, specially designed to obviate the inconvenience so frequently arising on account of the very limited range of motion admitted by those at present in common use. Regarding the fingers as the best means of movement, he had endeavoured to imitate their action, and had put the mechanical arrangement by which it was effected under the stage. He had shown the drawings to Prof. Abbe, who said he thought the idea was the best of the kind he had yet seen. The one which he had brought for exhibition that evening had been made from these drawings, and though not yet perfect in all its details, it was sufficiently so to render the principle of construction perfectly clear to any one who inspected it. It would be seen that the movement obtained across the stage was as much as 10 cm., and in the other direction it was 5 cm., which was not only larger than what was obtained in any other form, but it would carry the largest slip likely to be required, and would show it from end to end. It was also of great use for the purpose of observing living objects, as it would take a zoophyte trough, and not only keep it in position, but enable it to be moved from end to end without shaking or disturbing the contents; and it would also equally well carry a watch-glass with liquid in it, or a pair of light forceps for holding solid objects.

The President, in thanking Mr. Bernard for bringing this stage to their notice, expressed the opinion that it was likely to be found very useful for dissecting, during which he had often felt the inconvenience arising from the want of a greater range of movement in the ordinary mechanical stage.

Prof. Groves read a letter received from Mr. M. J. Hermann, describing the position of a pond in the neighbourhood of Balham, which he had recently found to contain *Volvox globator* in unusually large quantity. A sketch map indicating the exact locality accompanied the letter and was copied upon the blackboard.

The Hon. J. G. P. Vereker's paper "On the Resolution of Podura" was read by Prof. Groves, photomicrographs of various aspects described being exhibited in illustration.

The President said the subject was one which had often been before them, but he did not know if the explanation now given was exactly the same as they had heard before. Probably some of those present who were interested in the subject would be able to tell them.

Mr. Nelson said that a friend of his had done a great deal in this direction, examining scales of all sorts, bent scales, and broken ones in all sorts of ways, but had never yet seen featherlets sticking out in the manner described. Three little projections on a bent scale were the nearest things consistent with the idea of a beaded scale, and he believed that the effects were due to nothing more than a thickening of the membrane. With regard to the base markings, these were shown many years ago in the old rooms at King's College by Mr. Powell, at the time he brought out his new oil-immersion lens. The mottling between the "exclamation" markings they had of course all seen, he had in fact often used these little crinkly markings as tests, but the cause of Dr. Piggott's beads was the false appearance produced by this crinkling when viewed with oblique light, which had the effect of notching on the exclamation marks. With regard to Dr. Edmunds' illuminator, it illuminated nothing unless it was mounted on the slip, and its practical effect was to reduce an oil-immersion to something worse than an ordinary dry lens, and as to what could be made out under such conditions he could only say that if things could not be seen with the best means obtainable, it was not very likely that they would be with those which were inferior. Few persons had much idea of the great difference there was in these podura scales until they began to examine a number of them; he had at times gone over a lot of about 100 of them, and after careful sorting, had only been able to pick out about three or four as being worth having as test objects.

Mr. J. E. Ingpen almost thought that Mr. Wenham considered that he had isolated the portions of the scale which caused the appearance of the "note of exclamation"—this was many years ago, at the time he used to take an active interest in the meetings of the Society. He was not quite sure, speaking only from memory, but he believed it was done by heating the scale in some way on a slide, and that Mr. Wenham had succeeded in absolutely isolating this portion of the scale; he, at that time, considered the markings to be inflations of the membrane, but certainly capable of isolation.

Mr. T. H. Gill fancied there was some one who said he had blown them off by an electric discharge.

Mr. Nelson said at one time he possessed a slide which had an isolated admiration mark, but he had never found a scale with one missing, and he concluded that when things looking like isolated marks were found occurring on slides, they were due to the methods of mounting. Occasionally small crystals were found, but they did not come from the scale.

The President reminded the Fellows present that their next meeting would be the Anniversary, and it would therefore be necessary to

appoint two Auditors to examine the Treasurer's accounts which would have to be presented at the Annual Meeting. On behalf of the Council he appointed Mr. W. T. Suffolk to this office, and asked those who were present to elect some other Fellow to act with him.

Mr. Nelson thereupon proposed Mr. J. M. Allen as Auditor on the part of the Fellows of the Society. This proposition, having been seconded by Mr. Wynne E. Baxter, was put to the meeting and unanimously carried.

The President read the list of Fellows who were nominated by the Council as Officers and Council for the ensuing year.

The following Instruments, Objects, &c., were exhibited:—

Mr. H. Bernard.—New Mechanical Stage.

The Hon. J. G. P. Vereker.—Photomicrographs of Podura Seales.

New Fellows.—The following were elected *Ordinary* Fellows:—Mr. Alfred Thomas Burgess, Dr. Edmond William Wace Carlier, Mr. Peter David Coghill, Sir John Coode, K.C.M.G., Messrs. Ludovico W. Hart, Edward Heron-Allen, and B. Rama Shastri.

ANNUAL MEETING, HELD 20TH JANUARY, 1892, AT 20, HANOVER SQUARE, W., THE PRESIDENT (DR. R. BRAITHWAITE, F.L.S.) IN THE CHAIR.

The Minutes of the meeting of 16th December last were read and confirmed, and were signed by the President.

Prof. Bell said that the Society had been unable to follow the example of several other scientific bodies who had suspended their meetings, arranged to be held on that evening, out of consideration for the memory of His late Royal Highness the Duke of Clarence and Avondale, whose funeral had taken place that afternoon. The reason for this was, that they were required by their Bye-laws to hold the Annual Meeting of the Society on that particular date, and no alteration could be made without a suspension of the Bye-laws for the purpose. To do this would have required a special meeting to be convened, for which a week's notice was necessary, and as the time at disposal had not been sufficient for this notice to be given, there was no alternative open to them. The Council had, however, decided only to take on that occasion such purely formal business as was necessary for the purposes of the Annual Meeting, and to adjourn the sitting as soon as this was completed. The President's Address and other matters would consequently be postponed until their next meeting.

Prof. Bell also said that bearing in mind the sad event which had so recently occurred, especially with regard to the fact that the Prince of Wales was the Patron of the Society, the Council had drawn up a message of sympathy, which would be submitted in due course to His Royal Highness.

The text of the Message, as follows, was then read :—

“ Royal Microscopical Society,
20, Hanover Square, W.

“ The President, Council, and Fellows of the Royal Microscopical Society desire to express their sympathy with their Patron in the great trouble and loss that has befallen him, and they dutifully beg to offer their sincerest condolence to His Royal Highness and to his family on the sad and sudden death of his eldest son.”

The President having expressed the opinion that the terms of this message of condolence would commend themselves to the feelings of all who had heard it read, submitted it to the meeting, and it was adopted.

Prof. Bell then read the Report of the Council for the past year, as follows :—

REPORT OF THE COUNCIL.

Fellows.—During the year 1891, thirty-six new Fellows were elected, fifteen have died, and thirty-eight resigned; the considerable increase in the number of resignations is explained by the Treasurer's efforts to obtain subscriptions due to the Society from Fellows who have ceased to interest themselves in its affairs.

Three Honorary Fellows, Dr. Henry Bowman Brady, Dr. Carl Wilhelm von Nägeli, and Prof. Joseph Leidy died; the vacant places have been supplied by the election of Prof. Herrman Fol, of Nice, the distinguished embryologist, Prof. Sir Joseph Lister, whose scientific investigations into the minuter forms of life have effected a revolution in surgery, Prof. Thomas Henry Huxley, of whose work it is unnecessary to remind the Fellows of this Society, and Dr. Edward Bornet, of Paris, well known for his writings on Algæ.

The list of Fellows now contains the names of 645 Ordinary, 1 Corresponding, 50 Honorary, and 89 Ex-officio, or a total of 785.

The late Secretary.—Although the Society has already expressed the deep regret which it felt at the death of Mr. John Mayall, jun., the Council cannot but again, in reviewing the year's work, remind the Fellows of the many valuable services which their late Secretary rendered to the Society, and put on record here their sense of the great loss which Mr. Mayall's death inflicted on microscopical science.

Finances.—Owing to the exertions of the Treasurer, the annual revenue from subscriptions has been increased by 79*l.* 7*s.* 10*d.*, but this increase must be regarded as abnormal, owing to the resignations of various Fellows already alluded to.

The Council note with great satisfaction the increased sale of the Journal, there being an increase of 62*l.* over that of last year.

Insurance.—With the assent of the Council the Treasurer has increased the Fire Insurance policy of the Society from 1500*l.* to 2000*l.*, and at the same time has effected a considerable reduction in the premium paid thereon, so that the Society is now paying a smaller premium for a larger amount insured.

Rooms.—When the negotiations now in progress with the Society's 1892.

landlords are concluded, the Council propose to increase the facilities to the Fellows for the use of their rooms.

Library.—The Council report that the whole of the Library has been re-arranged, preparatory to press-marking and re-cataloguing. This arrangement, which will be completed shortly, will increase the usefulness of the Library to the Fellows.

The Registration of the Society.—In accordance with the motion passed at the Special Meeting of the Society, held on Wednesday, 18th November last, the Society has been registered under the "Scientific and Literary Societies Act," 6 and 7 Viet., Cap. 36.

Journal.—The considerable increase in the sale of the Society's Journal to non-fellows justifies the original expectation of Mr. Crisp that time only was needed to make its value appreciated by the scientific public generally, and the Council feel justified in the hope that the Journal will continue to be a credit to the Society.

The Fellows will have noticed the list of new Botanical and Zoological terms in the concluding number of the Journal of last year. The thanks of the Society are due to Prof. T. Jeffery Parker, of Otago, N.Z., who suggested this valuable idea.

The Council must again, however, remind the Fellows that the scientific status of the Society at large must depend upon the character of the contributions printed in the Transactions and contributed by the Fellows; they observe with pleasure that there were twice as many contributions by Fellows in 1891 as there were in 1890.

Assistant Secretary and Librarian.—Mr. James West having ceased to be Assistant Secretary, the Council have appointed Mr. W. H. Brown, of the Geological Department, British Museum (Nat. Hist.), to the office. The Council have every reason to be satisfied with their appointment, as Mr. Brown has already shown himself a useful and capable assistant.

Mr. J. J. Vezey thought that the Report just read would be regarded as very satisfactory, and one therefore upon which the Society was to be congratulated. He had great pleasure in moving that it be received and adopted.

Mr. J. E. Ingpen seconded the motion.

The President, having put it to the meeting, declared it carried unanimously.

The Treasurer, Mr. Frank Crisp, read his statement of the accounts and submitted the balance-sheet for the year 1891, duly audited by Messrs. J. Mason Allen and W. T. Suffolk, the Auditors elected at the preceding meeting (see p. 170).

The President, having moved from the chair, "That the Treasurer's accounts for the past year be received and adopted," put it to the meeting, and declared it unanimously carried.

The President said their next business was to elect the Officers and Council for the ensuing year, for which purpose it would be necessary for scrutineers to be appointed to collect and examine the ballot papers. He, therefore, nominated Mr. J. M. Allen and Mr. J. G. Grenfell to act

Dr.

THE TREASURER'S ACCOUNT FOR 1891.

Cr.

1891.		£	s.	d.	1891.		£	s.	d.
To Balance brought from 31st December, 1890	..	110	10	2	By Rent, Coals, and Attendance	..	..	..	169 7 0
" Interest on Investments	..	87	14	9	" Salaries, Reporting, and Commission	..	..	..	136 18 9
" Admission Fees	..	67	4	0	" Books and Binding	..	..	..	88 1 5
" Annual Subscriptions	..	963	11	0	" Expenses of Journal	..	..	..	943 19 2
" Journals sold ..	..	324	6	4	" Postage of Journal	..	..	..	51 16 4
" Reprints of papers sold	..	..	..	..	" Reprints of Papers	..	..	..	4 4 0
" Woodcuts sold	..	0	18	9	" Stationery and Miscellaneous Printing	..	..	..	15 2 4
" Catalogues sold	..	2	7	6	" Contribution to Stair-carpet	..	..	..	5 15 4
" Advertisements	..	0	10	8	" Refreshments at Evening Meetings	..	..	..	19 6 0
	..	20	0	0	" Fire Insurance	..	..	..	1 10 0
	..				" Petty Cash	..	..	..	42 5 5
	..				" Balance remaining 31st December, 1891	..	..	..	98 17 5
		<hr/> £1577 3 2 <hr/>							£1577 3 2

FRANK CRISP, *Treasurer.*

Investments, 31st December, 1891.

1200*l.* Freehold Mortgages. 780*l.* 17*s.* 3*d.* India Three per Cents. (including 100*l.* Quekett Memorial Fund).

The foregoing Annual Account examined and found correct, 5th January, 1892.

W. T. SUFFOLK, } *Auditors.*
J. MASON ALLEN, }

as scrutineers on the occasion. These gentlemen having shortly afterwards handed in their report as to the result of the ballot,

The President declared the following Fellows to be elected as Officers and Council for the ensuing year:—

President—Robert Braithwaite, Esq. M.D., M.R.C.S., F.L.S.

Vice-Presidents—*Alfred W. Bennett, Esq., M.A., B.Sc., F.L.S.; Prof. J. William Groves, F.L.S., *George C. Karop, Esq., M.R.C.S.; and Albert D. Michael, Esq., F.L.S.

Treasurer—Frank Crisp, Esq., LL.B., B.A., V.P. and Treas. L.S.

Secretaries—Prof. F. Jeffrey Bell, M.A.; and Rev. W. H. Dallinger, LL.D., F.R.S.

Twelve other Members of the Council—Prof. Lionel S. Beale, M.B., F.R.C.P., F.R.S.; *Rev. Edmund Carr, M.A., F.R.Met.S.; James Glaisher, Esq., F.R.S., F.R.A.S.; Richard G. Hebb, Esq., M.A., M.D.; *Edward Milles Nelson, Esq.; Thomas H. Powell, Esq.; Prof. Urban Pritchard, M.D.; Walter W. Reeves, Esq.; *Prof. Charles Stewart, Pres.L.S.; William Thomas Suffolk, Esq.; *Charles Tyler, Esq., F.L.S.; and Frederick H. Ward, Esq., M.R.C.S.

The President said this concluded the necessary business of the Annual Meeting. The proceedings were then adjourned to February 17th.

New Fellows:—The following were elected *Ordinary* Fellows:—Messrs. Thomas Edward Freshwater and William Henry Maw, Prof. D. P. Penhallow, Sir David Lionel Salomons, Bart., and Mr. Henry Leland Tolman.

* Have not held during the preceding year the office for which they were nominated.

The Journal is issued on the third Wednesday of
February, April, June, August, October, and December.

1892. Part 2.

APRIL.

{ To Non-Fellows,
Price 5s.

JOURNAL OF THE ROYAL MICROSCOPICAL SOCIETY;

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS,

AND A SUMMARY OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.

Edited by

F. JEFFREY BELL, M.A.,

One of the Secretaries of the Society

and Professor of Comparative Anatomy and Zoology in King's College;

WITH THE ASSISTANCE OF THE PUBLICATION COMMITTEE AND

A. W. BENNETT, M.A., B.Sc., F.L.S.,

Lecturer on Botany at St. Thomas's Hospital,

R. G. HEBB, M.A., M.D. (Cantab.), AND

J. ARTHUR THOMSON, M.A.,

Lecturer on Zoology in the School of Medicine,

Edinburgh,

FELLOWS OF THE SOCIETY.



WILLIAMS & NORGATE,
LONDON AND EDINBURGH.

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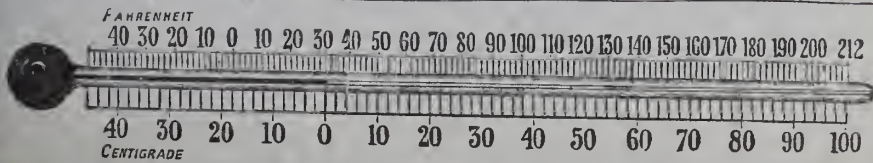
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APERTURE TABLE.

Numerical Aperture. ($n \sin u = a$.)	Corresponding Angle (2u) for			Limit of Resolving Power, in Lines to an Inch.			Illuminating Power. (a^2 .)	Penetrating Power ($\frac{1}{a}$)
	Air ($n = 1.00$.)	Water ($n = 1.33$.)	Homogeneous Immersion ($n = 1.52$.)	White Light. ($\lambda = 0.5269 \mu$, Line E.)	Monochromatic (Blue) Light. ($\lambda = 0.4861 \mu$, Line F.)	Photography. ($\lambda = 0.4000 \mu$, Near Line h.)		
1.52	..	..	180° 0'	146,543	158,845	193,037	2.310	.658
1.51	..	..	166° 51'	145,579	157,800	191,767	2.280	.662
1.50	..	..	161° 23'	144,615	156,755	190,497	2.250	.667
1.49	..	..	157° 12'	143,651	155,710	189,227	2.220	.671
1.48	..	..	153° 39'	142,687	154,665	187,957	2.190	.676
1.47	..	..	150° 32'	141,723	153,620	186,687	2.161	.680
1.46	..	..	147° 42'	140,759	152,575	185,417	2.132	.685
1.45	..	..	145° 6'	139,795	151,530	184,147	2.103	.690
1.44	..	..	142° 39'	138,830	150,485	182,877	2.074	.694
1.43	..	..	140° 22'	137,866	149,440	181,607	2.045	.699
1.42	..	..	138° 12'	136,902	148,395	180,337	2.016	.709
1.41	..	..	136° 8'	135,938	147,350	179,067	1.988	.709
1.40	..	..	134° 10'	134,974	146,305	177,797	1.960	.714
1.39	..	..	132° 16'	134,010	145,260	176,527	1.932	.719
1.38	..	..	130° 26'	133,046	144,215	175,257	1.904	.725
1.37	..	..	128° 40'	132,082	143,170	173,987	1.877	.729
1.36	..	..	126° 58'	131,118	142,125	172,717	1.850	.735
1.35	..	..	125° 18'	130,154	141,080	171,447	1.823	.741
1.34	..	..	123° 40'	129,189	140,035	170,177	1.796	.746
1.33	..	180° 0'	122° 6'	128,225	138,989	168,907	1.769	.752
1.32	..	165° 56'	120° 33'	127,261	137,944	167,637	1.742	.758
1.30	..	155° 38'	117° 35'	125,333	135,854	165,097	1.690	.769
1.28	..	148° 42'	114° 44'	123,405	133,764	162,557	1.638	.781
1.26	..	142° 39'	111° 59'	121,477	131,674	160,017	1.588	.794
1.24	..	137° 36'	109° 20'	119,548	129,584	157,477	1.538	.806
1.22	..	133° 4'	106° 45'	117,620	127,494	154,937	1.488	.820
1.20	..	128° 55'	104° 15'	115,692	125,404	152,397	1.440	.833
1.18	..	125° 3'	101° 50'	113,764	123,314	149,857	1.392	.847
1.16	..	121° 26'	99° 29'	111,835	121,224	147,317	1.346	.862
1.14	..	118° 0'	97° 11'	109,907	119,134	144,777	1.300	.877
1.12	..	114° 44'	94° 55'	107,979	117,044	142,237	1.254	.893
1.10	..	111° 36'	92° 43'	106,051	114,954	139,698	1.210	.909
1.08	..	108° 36'	90° 34'	104,123	112,864	137,158	1.166	.926
1.06	..	105° 42'	88° 27'	102,195	110,774	134,618	1.124	.943
1.04	..	102° 53'	86° 21'	100,266	108,684	132,078	1.082	.962
1.02	..	100° 10'	84° 18'	98,338	106,593	129,538	1.040	.980
1.00	180° 0'	97° 31'	82° 17'	96,410	104,503	126,998	1.000	1.000
0.98	157° 2'	94° 56'	80° 17'	94,482	102,413	124,458	.960	1.020
0.96	147° 29'	92° 24'	78° 20'	92,554	100,323	121,918	.922	1.042
0.94	140° 6'	89° 56'	76° 24'	90,625	98,223	119,378	.884	1.064
0.92	133° 51'	87° 32'	74° 30'	88,697	96,143	116,838	.846	1.087
0.90	128° 19'	85° 10'	72° 36'	86,769	94,053	114,298	.810	1.111
0.88	123° 17'	82° 51'	70° 44'	84,841	91,963	111,758	.774	1.136
0.86	118° 38'	80° 34'	68° 54'	82,913	89,873	109,218	.740	1.163
0.84	114° 17'	78° 20'	67° 6'	80,984	87,783	106,678	.706	1.190
0.82	110° 10'	76° 8'	65° 18'	79,056	85,693	104,138	.672	1.220
0.80	106° 16'	73° 58'	63° 31'	77,128	83,603	101,598	.640	1.250
0.78	102° 31'	71° 49'	61° 45'	75,200	81,513	99,058	.608	1.282
0.76	98° 56'	69° 42'	60° 0'	73,272	79,423	96,518	.578	1.316
0.74	95° 28'	67° 37'	58° 16'	71,343	77,333	93,979	.548	1.351
0.72	92° 6'	65° 32'	56° 32'	69,415	75,242	91,439	.518	1.389
0.70	88° 51'	63° 31'	54° 50'	67,487	73,152	88,899	.490	1.429
0.68	85° 41'	61° 30'	53° 9'	65,559	71,062	86,359	.462	1.471
0.66	82° 36'	59° 30'	51° 28'	63,631	68,972	83,819	.436	1.515
0.64	79° 36'	57° 31'	49° 48'	61,702	66,882	81,279	.410	1.562
0.62	76° 38'	55° 34'	48° 9'	59,774	64,792	78,739	.384	1.613
0.60	73° 44'	53° 38'	46° 30'	57,846	62,702	76,199	.360	1.667
0.58	70° 54'	51° 42'	44° 51'	55,918	60,612	73,659	.336	1.724
0.56	68° 6'	49° 48'	43° 14'	53,990	58,522	71,119	.314	1.786
0.54	65° 22'	47° 54'	41° 37'	52,061	56,432	68,579	.292	1.852
0.52	62° 40'	46° 2'	40° 0'	50,133	54,342	66,039	.270	1.923
0.50	60° 0'	44° 10'	38° 24'	48,205	52,252	63,499	.250	2.000
0.45	53° 30'	39° 33'	34° 27'	43,385	47,026	57,149	.203	2.222
0.40	47° 9'	35° 0'	30° 31'	38,564	41,801	50,799	.160	2.500
0.35	40° 58'	30° 30'	26° 38'	33,744	36,576	44,449	.123	2.857
0.30	34° 56'	26° 4'	22° 46'	28,923	31,351	38,099	.090	3.333
0.25	28° 58'	21° 40'	18° 56'	24,103	26,126	31,749	.063	4.000
0.20	23° 4'	17° 18'	15° 7'	19,282	20,901	25,400	.040	5.000
0.15	17° 14'	12° 58'	11° 19'	14,462	15,676	19,050	.023	6.667
0.10	11° 29'	8° 38'	7° 34'	9,641	10,450	12,700	.010	10.000
0.05	5° 44'	4° 18'	3° 46'	4,821	5,252	6,350	.003	20.000

COMPARISON OF THE FAHRENHEIT AND CENTIGRADE THERMOMETERS.

Fahr.	Centigr.	Fahr.	Centigr.	Fahr.	Centigr.	Fahr.	Centigr.	Fahr.	Centigr.
°	°	°	°	°	°	°	°	°	°
212	100	158	70	104	40	50	10	- 4	- 20
210·2	99	156·2	69	102·2	39	48·2	9	- 5·8	- 21
210	98·89	156	68·89	102	38·89	48	8·89	- 6	- 21·11
208·4	98	154·4	68	100·4	38	46·4	8	- 7·6	- 22
208	97·78	154	67·78	100	37·78	46	7·78	- 8	- 22·22
206·6	97	152·6	67	98·6	37	44·6	7	- 9·4	- 23
206	96·67	152	66·67	98	36·67	44	6·67	- 10	- 23·33
204·8	96	150·8	66	96·8	36	42·8	6	- 11·2	- 24
204	95·56	150	65·56	96	35·56	42	5·56	- 12	- 24·44
203	95	149	65	95	35	41	5	- 13	- 25
202	94·44	148	64·44	94	34·44	40	4·44	- 14	- 25·56
200·2	94	147·2	64	93·2	34	39·2	4	- 14·8	- 26
200	93·33	146	63·33	92	33·33	38	3·33	- 16	- 26·67
199·4	93	145·4	63	91·4	33	37·4	3	- 16·6	- 27
198	92·22	144	62·22	90	32·22	36	2·22	- 18	- 27·78
197·6	92	143·6	62	89·6	32	35·6	2	- 18·4	- 28
196	91·11	142	61·11	88	31·11	34	1·11	- 20	- 28·89
195·8	91	141·8	61	87·8	31	33·8	1	- 20·2	- 29
194	90	140	60	86	30	32	0	- 22	- 30
192·2	89	138·2	59	84·2	29	30·2	- 1	- 23·8	- 31
192	88·89	138	58·89	84	28·89	30	- 1·11	- 24	- 31·11
190·4	88	136·4	58	82·4	28	28·4	- 2	- 25·6	- 32
190	87·78	136	57·78	82	27·78	28	- 2·22	- 26	- 32·22
188·6	87	134·6	57	80·6	27	26·6	- 3	- 27·4	- 33
188	86·67	134	56·67	80	26·67	26	- 3·33	- 28	- 33·33
186·8	86	132·8	56	78·8	26	24·8	- 4	- 29·2	- 34
186	85·56	132	55·56	78	25·56	24	- 4·44	- 30	- 34·44
185	85	131	55	77	25	23	- 5	- 31	- 35
184	84·44	130	54·44	76	24·44	22	- 5·56	- 32	- 35·56
183·2	84	129·2	54	75·2	24	21·2	- 6	- 32·8	- 36
182	83·33	128	53·33	74	23·33	20	- 6·67	- 34	- 36·67
181·4	83	127·4	53	73·4	23	19·4	- 7	- 34·6	- 37
180	82·22	126	52·22	72	22·22	18	- 7·78	- 36	- 37·78
179·6	82	125·6	52	71·6	22	17·6	- 8	- 36·4	- 38
178	81·11	124	51·11	70	21·11	16	- 8·89	- 38	- 38·89
177·8	81	123·8	51	69·8	21	15·8	- 9	- 38·2	- 39
176	80	122	50	68·2	20	14	- 10	- 40	- 40
174·2	79	120·2	49	66	19	12·2	- 11	- 41·80	- 41
174	78·89	120	48·89	66·4	18·89	12	- 11·11	- 42	- 41·11
172·4	78	118·4	48	64	18	10·4	- 12	- 43·60	- 42
172	77·78	118	47·78	64·6	17·78	10	- 12·22	- 44	- 42·22
170·6	77	116·6	47	62	17	8·6	- 13	- 45·40	- 43
170	76·67	116	46·67	62·8	16·67	8	- 13·33	- 46	- 43·33
168·8	76	114·8	46	60	16	6·8	- 14	- 47·20	- 44
168	75·56	114	45·56	60	15·56	6	- 14·44	- 48	- 44·44
167	75	113	45	59	15	5	- 15	- 49	- 45
166	74·44	112	44·44	58	14·44	4	- 15·56	- 50	- 45·56
165·2	74	111·2	44	57·2	14	3·2	- 16	- 50·80	- 46
164	73·33	110	43·33	56	13·33	2	- 16·67	- 52	- 46·67
163·4	73	109·4	43	55·4	13	1·4	- 17	- 52·60	- 47
162	72·22	108	42·22	54	12·22	0	- 17·78	- 54	- 47·78
161·6	72	107·6	42	53·6	12	- 0·4	- 18	- 54·40	- 48
160	71·11	106	41·11	52	11·11	- 2	- 18·89	- 56	- 48·89
159·8	71	105·8	41	51·8	11	- 2·2	- 19	- 56·20	- 49
								- 58	- 50



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Wednesday, JANUARY 20	Wednesday, MAY 18
(Annual Meeting for Election of Officers and Council.)	„ JUNE 15
„ FEBRUARY 17	„ OCTOBER 19
„ MARCH 16	„ NOVEMBER 16
„ APRIL 20	„ DECEMBER 21

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II.



I.



III.



Amphipleura pellucida.

JOURNAL
OF THE
ROYAL MICROSCOPICAL SOCIETY.

APRIL 1892.

TRANSACTIONS OF THE SOCIETY.

III.—*The Resolution of Amphipleura pellucida.*

By J. W. GIFFORD.

(Read 18th November, 1891.)

PLATE III.

IN September last, Mr. C. Lees Curties was kind enough to show me a prism arrangement devised by Mr. Nelson for the production of monochromatic light in a form adapted for use with high power Microscope objectives. He drew my attention to the advantages attendant on its use, and showed me a frustule of *Surirella gemma*, clearly resolved by a Zeiss apochromatic 6 mm. In the course of conversation I asked if it were a fact, that, as reported, *A. pellucida* had been resolved into distinct dots by the new Zeiss apochromatic 2·5 mm. of 1·6 N.A. On this he expressed a doubt,* but remarked that *A. Lindheimeri* was without difficulty so resolvable.

I then thought the matter out and determined to examine a frustule of *A. pellucida* with sodium flame illumination, as being the most convenient and effective form of monochromatic light I could think of at the time. I was much pleased to find, even at the first attempt, that *A. pellucida* unmistakably showed dots, which became much more marked as the frustule was shifted to the side of the field of view.

At this point I communicated with Mr. Curties, who advised me to photograph what I had seen. And now the question arose as to the possibility of producing such photographs by the light of the sodium flame, and Mr. Curties very materially helped me by suggesting bathed plates, treated with an erythrosine bath.

EXPLANATION OF PLATE III.

Fig. 1 \times 1300; taken with Powell & Lealand's O.I. 1/12 in. N.A. 1·43.
" 2 \times 1650 } taken with Powell & Lealand's O.I. 1/20 in. N.A. 1·5.
" 3 \times 2080 }

* Dr. Van Heurck has published photomicrographs of this diatom with the heading clearly shown by means of the 2·5 obj. N.A. 1·60. These were produced in this Journal, and a separate plate with the same result is given in Dr. Dallinger's (7th) edition of 'The Revelations of the Microscope,' 1891.—[Ed. J.R.M.S.]

It occurred to me that a trough containing solution of iron perchloride used as a screen would cut off all the blue end of the spectrum, and some of the green, leaving only the green-yellow, yellow, and red; but on the other hand I found that erythrosine plates were only sensitive as far down as the yellow, being more especially sensitive to this green-yellow. I found that in this way the part of the spectrum used for photographing could be reduced to a narrow band about midway between the D lines and the E line in the solar spectrum. By this means I succeeded in obtaining the photographs now before you, which I have carefully avoided touching up in any way whatever. All that I claim for them is that they show approximately what I saw with the sodium flame, and which I was unable to photograph. For, by experiments with the sodium flame and low powers, I found that to photograph *A. pellucida* under the powers I had, and with either the erythrosine or cyanine plates I had prepared, an exposure of from 60 to 70 hours would be necessary.

Whether these markings are true or spurious, is a question I do not touch, but I may perhaps venture to say that they appear to me to have as good a claim as those on *Surirella*. But I think it more probable that in both cases they are simply multiplied images of the midrib and sides produced by the higher orders of diffraction spectra. As already mentioned, it is only at the side of the field of view that the second set of lines comes strongly into view. In the centre one only gets "samples," but now and then there is even there a distinct beaded appearance.

The mounts of *A. pellucida* used were of realgar or rather a higher sulphide of arsenic prepared by melting sulphur with realgar. I have found that it is possible, though extremely difficult, to make mounts with such a large proportion of realgar, that they are of a deep orange colour inclining to red, and that with such mounts the coloured screen may be dispensed with. But these extremely highly refracting media very soon crack off from the cover-glass like phosphorus, which I have been obliged to abandon.

One of the advantages of working with this arrangement of light and a suitable colour-correct plate is that ordinary achromatic object-glasses perform almost as well as apochromatics, the visual rays and those used for the photograph being practically identical.

I may add that I have been unable to see these beaded markings with any glass of less aperture than 1.4; the best results were obtained by a 1/10 in. of 1.5 and a 1/20 in. of 1.5, both by Powell and Lealand, but it was shown exceedingly well by a 1/12 in. of 1.43 by the same makers. Of these the 1/10 in. is an apochromatic, the others achromatics. I have as yet not had an opportunity of trying the Zeiss apochromatics of large aperture. I attempted at first to photograph without an eye-piece, but once having put in a Zeiss projection ocular, results were so much improved that it was used throughout.

IV.—*The President's Address: On Reproduction in the Ferns and Bryophyta.*

By ROBERT BRAITHWAITE, M.D., &c.

(Read 17th February, 1892.)

I HAVE for the first time realized the difficulty I have heard expressed by my predecessors in this chair, viz. that of finding anything new as the subject for a discourse; and I have come to the conclusion that the editors of your Journal are mainly responsible for this—they have become so Raptorial that it matters not in what country or in what language anything new in biological science is made known, it is also through the medium of your Journal at once disseminated throughout the English-reading world.

What then is a poor President to do, unless he has abundance of time for original investigation? Science marches so fast that there is danger of some of the old truths being forgotten, so I am going to recall to your minds some facts in the reproduction of Ferns and Mosses which are not new, but which, in my opinion, afford a striking example of what our noble instrument—the Microscope—has enabled us to accomplish in making clear some of the deepest secrets of nature, not only in the groups mentioned, but in all that has life.

You all know something of the process of fertilization in flowering plants, how the anthers produce pollen, which at the proper time is shed on the prepared and moistened surface of the stigma, and how each pollen-grain throws out a fine tube which shoots down through the tissues of the style into the ovary, reaches an ovule, penetrates through the micropyle to the embryo-sac, and a spindle-shaped reproductive cell passes down this tube, divides into two, the anterior half enters the female cell, and the nuclei of the two become fused together, the ovule is impregnated, and develops into a seed capable of reproducing an individual like its parent.

In the groups we are going to consider, this process much more closely resembles that in the higher animals, and, thanks to the Microscope, the union so far from being *cryptic*, is capable of being observed from beginning to end. I have brought these two subclasses together, because they have also other points in common, notably an alternation of generations, for in none of them does the spore produce a plant like its parent, but an intermediate growth, a sexual one in the ferns, bearing the reproductive organs which are absent from the perfect plant, an asexual one in the others, from which the sexual plant buds off and develops into the spore-producing moss.

No doubt you have examined the beautiful ringed sporangium of a fern, which, when ruptured, gives exit to the dust-like spores; these bodies, when magnified, are seen to be subglobose and pyramidal, the outer coat or exospore being a thickish, coloured, tuber-

cular, spinulose or smooth skin, inclosing a hyaline cell with nuclei, and a similar but simpler spore is produced in the sporogone of mosses. Exposed to moisture, warmth, and light, growth commences in the fern-spore, the exospore is ruptured, and the endospore is protruded as a hyaline sausage-shaped vesicle, containing fine granules and mucilaginous protoplasm, in which also chlorophyll soon begins to form; this becomes septate and divided into a short branched pro-embryo, next one end widens out into a plate, and by more rapid lateral cell-division produces a reniform prothallus consisting of a single stratum of parenchymatous cells, fixed to the substratum on which it has developed by fine rhizoids or root-hairs, and it is on this little green embryonic growth, when about $\frac{1}{4}$ in. in diameter, that the organs of impregnation are found.

The great phytotomist Nägeli—so recently lost to us—first noticed the antherozoids in 1843, but it was the Polish Count Leszczyc Suminski who fully investigated the subject, and in 1848 gave us the result in a beautifully illustrated memoir ‘Zur Entwicklungs-Geschichte der Farnkräuter,’ dedicated to King Friedrich Wilhelm, who bore the cost of publication, and I well remember the stir made in the botanical world by this event, though, as usual with many great discoveries, it met with much ridicule and opposition. Both the antheridia or male organs and the archegonia or female are produced from single cells on the under surface of this little cellular expansion: the former lie chiefly among the root-hairs towards the side farthest from the marginal notch, as little globular projections of single cells, at first containing chlorophyll, but afterwards free cells filled with transparent globules or nuclei. As this cell grows up it becomes cut off from the prothallium cell by a transverse septum, small new cells appear filled with granules, and when ripe, the antheridium bursts at the apex, and out pour the slimy contents full of small round cells, each containing an antherozoid or spiral thread, having a club-shaped anterior extremity provided with 6–8 cilia, which have an active lashing movement. Between the middle of the prothallium and marginal notch are other ovate teat-like bodies composed of 10–12 cells, which originate also from single superficial cells of the prothallium; these are the archegonia; they develop into a spherical cavity, round which eventually four larger quadrate cells form, and vertically over each of these, three more cells are developed and lengthen the quadrangular space into a canal closed at apex by the terminal cells being applied to each other. The large cell at base divides by a transverse wall, the lower part forming the central cell of the archegonium, the upper the neck, and the central cell again divides into two, the lower part developing into the globular oosphere, the upper part into the canal cells, the contents of which, converted into mucilage, push apart the apical cells, and hang in a pellet in front of the aperture. Here we have a counterpart of what we may observe in many flowering plants, e. g. in *Lilium speciosum*, where at

the time of impregnation the stigma is covered with a slimy secretion, sometimes so profuse as to drip on the table beneath.

The antherozoids escape from the antheridia by the cover-cell becoming detached, and the contents are pressed out; these are the mother-cells of the antherozoids, which soon burst and allow them to escape; they are active for 30–40 minutes, and as if by an exercise of will, use the most determined efforts to reach the archegonia, where they force their way through the mucilaginous pellet to gain the neck, some pass down the canal into the oosphere, make a way into it at a thinner point termed the receptive spot, combine with its contents and disappear, the oosphere is fertilized and becomes an oospore.

The asexual generation or fern proper now commences its growth; the oospore divides into two by a septum parallel to the axis of the canal, and each of these again by a transverse septum, this embryo is then prolonged by lateral growth into the foot, by which it draws nutriment from the prothallus, and from one end of this proceeds the root, from the other the first leaf, and these gradually increase until the perfect fern is formed and becomes an independent plant enduring for an indefinite number of years.

The Bryophyta or Mosses form three natural divisions, the Bryinæ or true Mosses, Sphagninæ or Peat-mosses, and Hepaticæ or Liver-mosses, though the first two are commonly united. In these the sexual organs consist of antheridia and archegonia, but they are of simpler structure than in ferns, and it is the first generation from the spore which is asexual.

In the Mosses the spore bursts and emits the tubular endospore, which by repeated branching forms a septate confervoid protonema, visible as a felted stratum on damp ground, and highly chlorophyllose; from the lower cells of this by lateral budding sexual plants are produced, which develop leaves and eventually antheridia and archegonia. The antheridia are sausage-shaped bodies on a short pedicel, composed of a single layer of cells, thinner and more transparent at apex, and generally surrounded by filiform, jointed trichomes named paraphyses, and inclosed in bracts or floral leaves. The contents of these organs are the mother-cells of the antherozoids, which are somewhat clavate at the posterior end, spirally coiled and tapering in front to a fine point, where they have two long and very fine cilia. Hedwig, in 1782, figured these male organs discharging the pollen as he termed it. The archegonia are flask-shaped, tapering into a long trumpet-shaped style, and inclosing at base a central cell, the protoplasm of which forms the oosphere; above this is the canal of the style, formed as in ferns by the breaking up of the axial cells and formation of mucilage, which forces open the four apical cells and makes a passage for the antherozoids.

The fertile oospore enlarges by cell-division into an ovoid embryo which pushes its way into the tissue below the archegone, and also grows upward on a pedicel bearing at its apex the sporogone or

theca. While the spores are developing, the ventral part of the archegone continues to grow and enlarges into the calyptra, which is torn off and incloses the young sporogone, the basal part being left behind as the vaginula inclosing the seta. The spores originate in fours, each mother-cell dividing into four, and in all respects they resemble the spores of ferns.

The *Sphagna* differ from the true Mosses by the spongy cortical layers of the trunk, the branches collected in fascicles, the very curious and beautiful structure of their leaves, and the antheridia being subglobose in form, with very fine branched paraphyses and grouped as an amentum or catkin on an abbreviated branch. The spores of *Sphagnum*, if germinating in water, form a slender branched protonema, but if their development takes place on the ground, a lobed prothallus is formed resembling a plant of *Blasia*, and from the edges of the lobes young plants bud off.

The Hepaticæ or Liver-mosses vary much more among themselves than the Mosses, the majority of them are branched and leafy, but a considerable number retain permanently the thallose condition, the proembryo continuing to grow and branch out, without any new leaf-bearing generation. In the foliose *Jungermanniæ* the antheridia are globose as in *Sphagnum*, and, as in that genus, are often arranged on a short branch in amentiform clusters, or they may be solitary and axillar. In the thallose forms the sexual organs are on the upper surface, the ventral surface bearing scales and rhizoids, and the product of germination in the Hepaticæ resembles closely that of ferns.

In *Pellia*, for instance, the terminal cell of the spore elongates to form a root, the others multiply and expand into the flat horizontal thalliform trunk. In the leafy Hepaticæ three modes of development of the spore have been observed; in the group *Frullaniæ* a flat round disc is formed, and on the margin of this a bud is developed which grows into a leafy stem; in *Jungermanniæ* with round entire leaves, as *Plagiochila*, it is a thickened cylindric cellular mass, which is at once transformed at the apex into the trunk; in *Jungermanniæ* with cleft leaves, e. g. *Diplophyllum*, it is a slender branched thread of protonema, which produces a naked body from which the trunk is formed.

In *Marchantia* the frond sends out a branch which grows a certain height and is then transformed at the summit into a disc, bearing beneath many female inflorescences; this has been termed by Lindberg a *Carpocephalum*, and its peduncle a *Cephalopodium*. On the posterior part of this peduncle one or two deep furrows contain numerous radical cells, having in the interior claviform thickenings, and which has on the anterior part the epidermal orifices which serve as canals to small air-cavities, lined in the interior with rows of opuntiform cells. The common disc is more or less conical with four to ten rays, beneath and alternating with which are the widely bilabiate and fringed perichætia inclosing the sporogones. The male

inflorescence is a flat bluntly stellate disc, in the upper surface of which the antheridia are immersed. In *Targionia*, a single inflorescence is fixed at the summit of the frond on the under surface, and inclosed in a bivalve involucre. *Tessellina* and *Sphærocarpus* have numerous archegonia scattered over the frond, each covered by a special perianth; in *Riccia* the sexual organs are separate from each other, completely immersed in the frond, and consequently have no other envelope, and thus stand lowest among the Hepaticæ. In *Jungermanniaceæ* the female inflorescence is placed at the summit or on a special branch from the posterior axils, the archegonia being inclosed in an involucre, but in *Fossombronia* this is absent, and each female organ has a little proper perianth, while in *Anthoceros* they are sunk in the frond without any leafy organs to inclose them.

For an elaborate account of the development of the Hepaticæ I may refer to the admirable papers by the late Prof. Leitgeb of Graz, 'Untersuchungen über die Lebermoose' (1874-81).

Spores, however, are not the sole means of reproduction in mosses, but gemmæ or buds are not unfrequently produced, in the axils of leaves, on the nerve or laminæ of the leaves themselves, or in special terminal receptacles, and these falling to the earth, take root and develop new plants. Protonema is, however, usually first formed, from which the plants originate, and this protonema may spring from branches of root-hairs, or even from a single cell of a detached leaf, as has been noticed in *Funaria hygrometrica*, and in this way a species is propagated when the sporogone is never or but rarely produced.

To sum up, the Fern-spore, on germinating, does not produce a single plant as the seed of a phænogamous plant does, but a temporary nursing-mother prothallus, this also bears the sexual organs, from which a numerous progeny of asexual ferns spring. In the Moss-groups the first stage is asexual, and from it bud off the enduring sexual plants, which go on growing by annual innovations; the sexual organs placed on the same plant or on different plants, the process of impregnation in all of them being identical in detail with that of the highest animals.

We thus see what the Microscope has done in revealing to us all the stages of one of the most important processes of organic nature, for the continuance of the species, next to that of the individual, is the most dominant of all vital functions. And surely this suggests a thought on the mystery of life, a divine afflatus, impressed on creation at the beginning, which once lost, all the resources of science can never restore, yet handed down to us unaltered through countless bygone centuries, delighting us in our own short enjoyment of it by the endless manifestations of structure and beauty it is ceaselessly yet silently elaborating, and passing on unchanged through all the ages which are yet to come, doubtless to be still further unfolded to us in the life beyond.

V.—*Virtual Images and Initial Magnifying Power.*

By E. M. NELSON, F.R.M.S.

(Read 16th March, 1892.)

PROF. ABBE takes exception to the manner in which microscopists deal with the magnifying power of lenses.* He there speaks of what is called the initial magnifying power of a lens, which is determined by dividing a conventional length of 10 in. by the principal focal length of the lens.

Thus let m be the initial power, d the conventional accommodation or screen-distance of 10 in., and f the principal focal length of the lens, then $m = \frac{d}{f}$.

Although this expression is convenient, an undoubtedly erroneous meaning is usually attached to it. Let me illustrate this by an example. Let f , the focus of the lens, be 1 in., and the accommodation or screen distance $d = 10$ in., then by the formula $m = 10$. 10 is then the initial power of the lens. It must be remembered that this initial power is altogether an abstract thing, and one which is not realized in practice, except in one definite case, which will be dealt with presently.

It does not mean that if an object o (which we may call = 1) is placed before a converging lens of 1 in. focus, and a screen is placed 10 in. on the other side of the lens, that i , the size of the image on the screen, will = 10. I will not deny that it has often been made to mean that; it is nevertheless quite wrong to do so.

I must point out to those who are in the habit of making this serious mistake, that there are two points with regard to every lens which are of greater practical importance to the microscopist than the focus; these points are p , the point where the object o is situated, and p' where its image i is formed; p being the distance measured on the axis from the object o to the lens, and p' from the lens to the image i .

Now f is the principal focus of the lens, and is the point to which parallel rays are converged, but as there are no such things as parallel rays in any part of a Microscope, f has no place in practical microscopy.

The microscopist can therefore look upon f as an abstraction, and for him only useful for insertion in optical formulæ.

Now the point of first moment to the microscopist is the magnifying power of the instrument he is using, which in plain language is, how many times larger than o does the instrument cause me to see i ?

* Journal R. M. S., 1884, p. 348.

If m is the magnifying power, i the image, and o the object, $i = m o$, or $m = \frac{i}{o}$. m , therefore, may be practically determined by direct measurement of i and o , but it can also be found from purely optical considerations, because the proportion between i and o is identical with that between p' and p , so $\frac{i}{o} = \frac{p'}{p}$, and $m = \frac{p'}{p}$.

Therefore, if we know the distances of the object and the screen from the lens, we can find the magnifying power.

It is now that f , the focal length of the lens, becomes so useful, because, although p' is either known or can be measured, p is not usually known, and often cannot be conveniently measured. If, however, f is known, p can be expressed in terms of f and p' , and so all knowledge of p can be dispensed with.

In the simple Microscope there is no screen, p' is the nearest distance of accommodation, p however is not known, but as we know p' and f we can find p , and so determine m the magnifying power of any lens. The argument is as follows:—

$$m = \frac{i}{o} = \frac{p'}{p}; \quad \frac{1}{p} + \frac{1}{p'} = \frac{1}{f}, \quad \text{therefore} \quad p = \frac{p'f}{p' - f};$$

putting this value instead of p in the denominator of the fraction in the first equation and simplifying we get

$$m = \frac{p'}{\frac{p'f}{p' - f}} = \frac{p'}{f} - 1.$$

So in a simple Microscope we may readily find the power if we know f the principal focus of the lens, by substituting d the least distance of accommodation for p' .

One or two points require to be noticed with regard to this formula:—

(1) p is positive, but in the simple Microscope p' being measured from the lens to the image, or from right to left, is negative. Therefore m will be negative, which indicates that the image is virtual. When, however, a real image is received on a screen, p' is positive, and m is also positive, because when p' is less than f no image can be formed on the screen.

(2) The formula in the case of the simple Microscope assumes the eye to be placed close to the lens. When, however, the eye is placed at the back principal focus of the lens, p' is not equal to d , but is equal to $d - f$. Dropping, therefore, the negative sign for the virtual image, and considering d a positive quantity, we obtain the following formulæ for a simple Microscope:—

(i.) When the eye is held close to the lens

$$m = \frac{d}{f} + 1.$$

(ii.) When the eye is held at the back principal focus of the lens

$$m = \frac{d}{f}.$$

(iii.) For real images, calling the screen-distance d ,

$$m = \frac{d}{f} - 1.$$

This last formula shows that in our example above, the image on the screen would be 9, and not 10.

From these formulæ it may be seen that in the case of a low power it makes a greater percentage of difference whether the eye is held close to the lens, or at its principal focus, than when a high power is used. Thus with the same minimum accommodation distance of 8 in. and a 4 in. lens there is a difference of 50 per cent., but with a lens of 1/2 in. focus only 6 per cent.

The following is a table of magnifying powers for simple Microscopes of various foci, from 1/4 to 6 in., and with various least distances of accommodation, worked out according to the first formula, which assumes the eye to be held close to the lens.

Foci.	Least Distances of Accommodation.											
	3	4	5	6	7	8	9	10	11	12	13	14
$\frac{1}{4}$	13	17	21	25	29	33	37	41	45	49	53	57
$\frac{1}{3}$	10	13	16	19	22	25	28	31	34	37	40	43
$\frac{1}{2}$	7	9	11	13	15	17	19	21	23	25	27	29
$\frac{2}{3}$	$5\frac{1}{2}$	7	$8\frac{1}{2}$	10	$11\frac{1}{2}$	13	$14\frac{1}{2}$	16	$17\frac{1}{2}$	19	$20\frac{1}{2}$	22
$\frac{3}{4}$	5	$6\frac{1}{3}$	$7\frac{2}{3}$	9	$10\frac{1}{3}$	$11\frac{2}{3}$	13	$14\frac{1}{3}$	$15\frac{2}{3}$	17	$18\frac{1}{3}$	$19\frac{2}{3}$
1	4	5	6	7	8	9	10	11	12	13	14	15
$1\frac{1}{2}$	3	$3\frac{2}{3}$	$4\frac{1}{3}$	5	$5\frac{2}{3}$	$6\frac{1}{3}$	7	$7\frac{2}{3}$	$8\frac{1}{3}$	9	$9\frac{2}{3}$	$10\frac{1}{3}$
2	$2\frac{1}{2}$	3	$3\frac{1}{2}$	4	$4\frac{1}{2}$	5	$5\frac{1}{2}$	6	$6\frac{1}{2}$	7	$7\frac{1}{2}$	8
$2\frac{1}{2}$	$2\frac{1}{5}$	$2\frac{3}{5}$	3	$3\frac{2}{5}$	$3\frac{4}{5}$	$4\frac{1}{5}$	$4\frac{3}{5}$	5	$5\frac{2}{5}$	$5\frac{4}{5}$	$6\frac{1}{5}$	$6\frac{3}{5}$
3	2	$2\frac{1}{3}$	$2\frac{2}{3}$	3	$3\frac{1}{3}$	$3\frac{2}{3}$	4	$4\frac{1}{3}$	$4\frac{2}{3}$	5	$5\frac{1}{3}$	$5\frac{2}{3}$
$3\frac{1}{2}$	$1\frac{6}{7}$	$2\frac{1}{7}$	$2\frac{3}{7}$	$2\frac{4}{7}$	3	$3\frac{2}{7}$	$3\frac{4}{7}$	$3\frac{6}{7}$	$4\frac{1}{7}$	$4\frac{3}{7}$	$4\frac{5}{7}$	5
4	$1\frac{3}{4}$	2	$2\frac{1}{4}$	$2\frac{1}{2}$	$2\frac{3}{4}$	3	$3\frac{1}{4}$	$3\frac{1}{2}$	$3\frac{3}{4}$	4	$4\frac{1}{4}$	$4\frac{1}{2}$
5	$1\frac{3}{5}$	$1\frac{4}{5}$	2	$2\frac{1}{5}$	$2\frac{2}{5}$	$2\frac{3}{5}$	$2\frac{4}{5}$	3	$3\frac{1}{5}$	$3\frac{2}{5}$	$3\frac{3}{5}$	$3\frac{4}{5}$
6	$1\frac{1}{2}$	$1\frac{2}{3}$	$1\frac{5}{6}$	2	$2\frac{1}{6}$	$2\frac{1}{3}$	$2\frac{1}{2}$	$2\frac{2}{3}$	$2\frac{5}{6}$	3	$3\frac{1}{6}$	$3\frac{1}{3}$

To find the power when the eye is held at the back principal focal point, subtract 1 from the values given in the table, but if the magnification of a real image on a screen is required subtract 2, the accommodation distances being of course in this last case screen-distances. Thus with a lens of $1\frac{1}{2}$ in. focus, and a minimum distance

of accommodation of 8 in., if the eye is held close to the lens, the power will be, as in table, $6\frac{1}{3}$ (formula i.); but if the eye is held $1\frac{1}{2}$ in. from the lens, at the back principal focus, the power will be one less than that given in the table, or $5\frac{1}{3}$ (formula ii.).

The real image formed by the lens on a screen, distant 8 in. from the lens, will be amplified two diameters less than that in the table, or $4\frac{1}{3}$ times (formula iii.).

The expression, "The reciprocal of the focus is the power of the lens" was introduced by Herschel (Art. Light, Ency. Metrop.). In the paper referred to above, Abbe recommends microscopists to substitute this expression of Herschel's for the usual formula $m = \frac{f}{.01}$.

If Herschel's formula were adopted, the power of a 4-in. lens would be $1/4$, that of an inch 1, and a $1/2$ -in. 2. For my own part, while fully admitting the usefulness of "the reciprocal of the focus" for optical formulæ, I cannot see how the powers of the above lenses are more intelligibly rendered by the figures $1/4$, 1, and 2 than by the old notation of $2\frac{1}{2}$, 10, 20.

It must be understood that microscopists are not necessarily either opticians or mathematicians; so, if this new nomenclature were adopted, a note must be appended to explain that when an image produced by a 1-in. lens is viewed, either when virtual or on a screen, it will not be of the same size as the object, a meaning which the new nomenclature would seem to convey. It will be said that the figures given by the new nomenclature are only proportional to the power, a statement which gives us this highly interesting fact, that "the power of a lens" is proportional to its power! It will be noticed that, whether the old or new nomenclature is adopted, it will only hold true in the one case (formula ii.) of a virtual image, where the eye is held at the back principal focus of the lens. In each of the other cases neither nomenclature gives a correct answer, or even one proportional to it, but I think none will deny that the old nomenclature conveys a better general impression in these cases than the other is likely to do.

We now come to another point in Abbe's paper, where he states that the magnification is the same in the case of virtual images whatever the accommodation may be, because the images are viewed under the same visual angle. In order to discuss this often argued and much misunderstood subject it will be advisable to dispense with everything that is likely to cause confusion or ambiguity. I therefore propose to deal with the images on the retina, as the size of these under varying conditions can be exactly calculated. It will be necessary first to reduce the phrase "magnifying power" to its simplest terms. Magnifying power is the amount of the enlargement of the retinal image. The advantage of this definition lies in the fact that the retinal image is a real or screen image, and therefore we may dispense with all consideration of the ghostly virtual images and the

debatable projection distances which have caused so much argument in a circle, and unnecessary confusion of ideas. Let it be understood that when we speak of normal sight we mean a sight possessing a range of accommodating power for distances of 8 in. to ∞ , and when of myopic sight for distances of 4 in. to 8 in. The following six examples will illustrate the subject:—

(1) If an object $1\frac{1}{2}$ in. long is placed 8 in. in front of a normal eye, the image of that object on the retina will be $\cdot 031$ in.

(2) A myopic person, however, would hold the object 4 in. from the eye, and the image on the retina would be $\cdot 062$ in. long.

(3) If the normal eye used a lens 1 in. in focus, the eye being placed at the posterior focal point, the image on the retina would be enlarged to $\cdot 248$ in., or eight times more than in example (1), which enlargement, according to our definition, will represent the magnifying power.

(4) The myopic eye under similar conditions will have a retinal image of $\cdot 248$ in., or the same as with the normal eye; the magnifying power, however, will be only 4 times, the image on the myopic retina without the lens being twice the size of that on the normal retina.

If in these last two cases the power is actually measured by superimposing the magnified image seen by one eye on the unmagnified image seen by the other eye, the results will agree with the above.

(5) If the normal eye is placed close to the lens, the image on the retina will be $\cdot 279$ in., or 9 times larger than in case (1) without the lens.

(6) If the myopic eye is placed close to the lens, the image on the retina will be equal to $\cdot 31$ in., or 5 times larger than without the lens.

Hence it appears that, although in this last example the magnifying power is not so great as in example (5), the retinal image is somewhat larger.

By confining the argument to retinal images the discussion is, as we said above, much simplified, and we are enabled to see clearly that, although the resultant virtual image, so long as the eye is held at the posterior focal point of the lens, is the same size whether the eye is normal or myopic, the magnifying power is different.

Abbe, however, states that "The amplifying power of every system is always the same for both, because the image is seen under the same visual angle."

The following very important example can only be explained by my hypothesis:—Before giving the example, let me point out that any normal sighted person can make himself myopic by the use of a convex spectacle lens. Thus, if a normal sighted eye, whose least distance of accommodation is 8 in., uses a convex spectacle lens of 8 in. focus, the eye will be made similar to a myopic eye, whose least accommodating distance is 4 in.; so any of these examples can be performed by normal sighted persons. The important example is as

follows:—A normal sighted person, whose least accommodating distance is 8 in., uses a magnifying lens of 4 in. focus, the eye being placed at the posterior focal point.

The magnifying power will be 2, that is, 1 less than that given in the table (formula ii.). Now, in order that a myopic eye, whose nearest distance of accommodation is 4 in., and which is held at the posterior focal point of the same lens, may see the image under the same visual angle, the object must be brought into contact with the lens.

When an object is placed in contact with a thin lens, such as the spectacle lens under discussion, the magnifying power is unity; in formula (ii.) when $d = f$, $m = 1$; this means that the image is the same size as the object, or, in other words, the magnifying power of the lens is entirely neutralized. This simple experiment, which can be tried by every one, proves that the amplifying power of every system is not the same for both, because the image is seen under the same visual angle.

The truth is that, with the normal and myopic sight as defined in these examples, the amplification with the normal is twice as great as with the myopic sight.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

A. VERTEBRATA:—Embryology, Histology, and General.

a. Embryology.†

Human Embryo twenty-six days old.‡ —Mr. F. Mall gives an account of a very young human embryo so well preserved and so perfect in all respects as to justify careful study. The memoir consists entirely of descriptive details, some of which, however, may be noted. The embryo was flexed upon itself so as almost to form a circle; the nasal pit was a large shallow depression, well exposed on both sides. Three branchial arches were visible on the right, and four on the left side. There were twenty-seven right and twenty-four left protovertebræ. The extremities were well marked, and the anterior were somewhat larger than the posterior. The neural tube, when straightened, measured from end to end 17 mm. There was no indication of a permanent optic nerve; the vagus was composed of two enormous ganglia. Though there were no sympathetic ganglia, there were marked branches extending from the first six dorsal nerves. The bulk of the framework of the skeleton was composed of multipolar cells. The Wolffian body was very large and somewhat lobulated; the ducts extended throughout the body. The cloaca was pyramidal.

Origin of Nerve-cells and Fibres in the Embryo.§ —Prof. M. v. Lenhossék, using Golgi's method, has studied the origin of the nerve-cells and fibres in embryonic chicks and ducks. The first differentiation of the medulla is the establishment of a primary supporting system of

* The Society are not intended to be denoted by the editorial "we," and they do not hold themselves responsible for the views of the authors of the papers noted, nor for any claim to novelty or otherwise made by them. The object of this part of the Journal is to present a summary of the papers *as actually published*, and to describe and illustrate Instruments, Apparatus, &c., which are either new or have not been previously described in this country.

† This section includes not only papers relating to Embryology properly so called, but also those dealing with Evolution, Development, and Reproduction, and allied subjects.

‡ Journ. Morphol., v. (1891) pp. 459-80 (2 pls.).

§ Verh. Naturf. Gesellsch. Basel, ix. (1891) pp. 379-92 (2 figs.).

"radial fibres." With these, as His has shown, the nerve-cells have nothing to do, for they arise directly from mitoses of the germinal layer, and are new additions to the primary supporting system. Lenhossék describes the origin of the motor neuroblasts in the anterior horns of the cord, tracing them outwards from the germinal layer. The *membrana prima* or *membrana limitans externa* is due to a mosaic-like union of the terminal plates of the radial cells, and readily admits of the outgrowth of nerve-fibres from the cord. As early as the third or fourth day of incubation, the neuroblasts begin to give off processes, and become nerve-cells. The different layers of the cord then begin to be differentiated. The author traces the origin of the commissural cells and of the anterior horn. His conclusions are important corroborations of those already reached by His and Ramon y Cayal.

Development of Oviduct of Frog.*—Mr. E. W. MacBride in investigating the development of the oviduct in the Frog, found that it was necessary to use tadpoles in which the tail was being absorbed, or had just vanished. He finds that the oviduct arises opposite the first and not the third nephrostome of the pronephros; the whole of the duct arises in connection with a strip of modified peritoneum, and apparently by proliferation from it, and it is entirely independent of the Wolffian duct. The lumen of the duct appears quite close to the peritoneum, and in patches. These facts seem to show that the whole oviduct of the Frog is a production of the peritoneum; a somewhat similar view has been taken by Wiedersheim as regards the Crocodile and Turtle.

The ordinary view that the oviduct is part of the primitive pronephric duct is founded on what happens in Elasmobranchs, but in Ganoids, Amphibia, and Reptiles—groups which probably approximately represent stages in the actual line of descent of Vertebrates—the oviduct seems to be derived from a dorsal groove in the peritoneum.

Precocious Segregation of Sex-cells in *Micrometrus aggregatus*.†—Mr. C. H. Eigenmann has discovered that the sex-cells of this Teleostean can first be distinguished from the surrounding cells about the time the blastopore closes. They differ from those around them by having well-defined, rounded outlines, and in the uniform distribution of the chromatin in small granules. The appearances in later stages are described, and the suggestion is put forward, that the present position of the gonads in the Craniata is not the primitive one, but that the anterior gonads of *Branchiostoma* (*Amphioxus*) probably represent the earlier condition. From this forward position the germinal region has been extended backwards, the anterior part undergoing atrophy later on.

Development of *Batrachus Tau*.‡—Miss C. M. Clapp has a few notes on the development of the Toad-fish. This Teleostean exhibits an interesting Elasmobranch character by the delay of the closure of the blastopore, in consequence of the great amount of food-yolk; a notched blastopore, at a distance behind the embryo, has not till now been known in Teleosteans.

* Quart. Journ. Mic. Sci., xxxiii. (1892) pp. 273-81 (2 pls.).

† Journ. Morphol., v. (1891) pp. 481-92 (1 pl.).

‡ Tom. cit., pp. 494-501 (3 figs.).

Embryology of the Sea Bass.*—Dr. T. H. Morgan reports that those who desire a simple and straightforward account of the development of a single fish, from the egg to the time of hatching, will find it in Dr. H. V. Wilson's account of the development of *Serranus atrarius*, published in volume ix. of the Report of the United States Fish Commission. The most interesting addition to our knowledge is the discovery that the ear, branchial sense-organs, and organs of the lateral line arise from a common structure or embryonic foundation. Before the closure of the blastopore there is, behind the eye, a long shallow furrow in the nervous layer of the ectoderm. At two points this furrow deepens, and at these two points the auditory sac and branchial sense-organs are ultimately formed. The posterior portion of the furrow is the foundation of the lateral line.

Spermatogenesis in *Myxine glutinosa*.†—Mr. J. T. Cunningham has in consequence of Dr. Nansen's criticisms, re-investigated the development of the spermatozoa of this protandrous hermaphrodite. He finds that the cells in unripe capsules are spermatocytes, which multiply by karyokinetic division. At a certain period of development these cells cease to divide in this way, and commence to form spermatozoa; the nucleus of the spermatocyte loses its ordinary structure, and the whole of its chromatin is formed into a number, probably six or more, of pear-shaped bodies which may be called sperm-nuclei. By the activity of the protoplasm of the spermatoblast these nuclei separate one by one from the latter, passing out point foremost, and trailing a slender thread of protoplasm behind them. The thread breaks near the spermatocyte, and the free portion then forms the tail of a perfect spermatozoon. The author makes a critical comparison between the account he now gives and that which he first gave, and urges that there is no essential difference between them; Nansen's conjecture that originally each capsule contains a single large cell or spermatogonium is to some extent verified by a condition seen in the germinal proliferating tissue, where the separate germ-cells may be seen surrounded by stromal cells.

The mode of spermatogenesis in *Myxine* is, in many respects, unique, and resembles more closely that which occurs in certain Invertebrates—Ctenopods and Molluscs—than that which occurs in higher Vertebrates. The most similar process has been described by Jensen for the Mollusc *Triopa clavigera*. Mr. Cunningham uses the term spermatocyte in its etymological sense, and means by it the element which corresponds to what, in other cases, has been called a spermatogonium or spermatospore, which gives rise to a bundle of spermatozoa.

The testicular follicles of *Myxine* are, in structure and development, much simpler than those of the more highly organized Invertebrates; and, consequently, the history of the testis approximates very closely to that of the ovary; and, in fact, the male and females are exactly, or almost exactly, homologous. W. Müller has shown that the testis of *Petromyzon* is composed of follicles and cells similar to those of the testis of *Myxine*.

* Amer. Natural., xxv. (1891) pp. 1020-7.

† Quart. Journ. Micr. Sci., xxxiii (1891) pp. 169-86 (1 pl.).

Histogenesis of Nerve-cells and Neuroglia.*—Signor G. Valenti, in studying the development of the nervous system in Elasmobranch fishes (*Mustelus*, *Torpedo*, &c.), finds that the epithelial cells of the medullary canal give origin by indirect division to the embryonic neuroglia; that from the cells of the embryonic neuroglia there arise by various and gradual transformations the nerve-cells and neuroglia-cells of the adult; and that from the mesoblastic connective tissue around the canal some elements enter the outer layers of the cord and become neuroglia-cells.

β. Histology.

Terminology of Cell-division.†—Prof. W. Flemming regards “the formation of scientific terms as a necessary evil,” but in this paper he adds to the list. This is done in order to secure clearness in the future, and with special reference to Fol’s objection that the term “aster” has been used by Flemming in a sense different from that for which he (Fol) originally used it. So Flemming will henceforth substitute for “Aster” and “Dyaster” the terms “Astroid” and “Dyastroid.”

Nucleus and Cell-substance during Mitosis.‡—Dr. H. F. Müller finds, from observations on the elements of the blood in the spleen of *Triton*, that after the disappearance of the nuclear membrane in mitosis the cell-substance mingles with the nucleus. He believes that this intermingling is of importance in the physiology of indirect division.

The Intermediate Body in Cell-division.§—Dr. A. Geberg describes in the dividing cells of the cornea of *Triton* a minute intermediate body, like Flemming’s *Zwischenkörperchen*. The nuclei of the two daughter-cells were in the dyaster stage; the slight residual part between the two cells contained a minute corpuscle from which radiating threads appeared to rise.

Amitotic Division in the Spermatogonia of Salamandra.||—Herr F. Meves finds that amitotic division often occurs, especially in March and in September and October, while mitotic division also occurs, rarely in spring, more frequently in autumn, and predominantly from May till August. This periodicity suggests that the amitotic division is not necessary to the normal regeneration of the testes. The behaviour of the annular attractive sphere during the fragmentation of the spermatogonium-nucleus suggests that it exerts a mechanical influence in the division.

Indirect Division.¶—Prof. J. Frenzel describes in the mid-gut gland of *Carcinus naenas* and some other Crustaceans, a process of cell-division which is amitotic, but associated with a halving of the nucleolar substance. It is a “nucleolar nucleus-halving.”

He notes that the epithelial cells of the mid-gut usually divide without mitosis, and that while half of the mother-cell is discharged,

* Atti Soc. Tosc. Sci. Nat., vii. (1891) pp. 285-6.

† Anat. Anzeig., vii. (1892) pp. 26-32.

‡ S.B. K. Akad. Wiss. Wien, c. (1891) pp. 179-88 (1 pl.).

§ Anat. Anzeig., vi. (1891) pp. 623-5 (1 fig.)

|| Tom. cit., pp. 626-39 (11 figs.).

¶ Archiv f. Mikr. Anat., xxxix. (1892) pp. 1-32 (1 pl.)

the remaining half redivides. So H. E. Ziegler's generalization that direct nuclear division in Metazoa is never associated with cell-division, is not invariably true.

Protoplasmic Fibrils of Epithelial Cells.*—Dr. E. Kromayer has discovered a process of technique which is well adapted for showing intra- and inter-cellular protoplasmic fibrils. The sections are stained with alum-carmin, borax-carmin, or vesuvium; washed in water or alcohol; placed in aqueous solution of methyl-violet; washed in water; placed in potassium iodide solution for a second or two; washed in water; treated with anilin-xylo, and finally with xylo.

Sections of skin so treated show very distinctly the network of fibres throughout the cells, and the bridges between neighbouring cells. In the cylindrical cells the fibres run parallel to the long axis, are very strong, and often spirally twisted. The peculiarities in the other cells of the epidermis are carefully described. Dr. Kromayer regards the fibres as a sort of protective framework of the framework, but they are also extensible and contractile, and the basal fibres of the cylindrical cells establish a firm connection with the cutis.

Eosinophilous Cells in the Medulla of the Bones.†—Dr. J. von Scarpatetti has made some observations—not as yet very conclusive—on the eosinophilous cells in the medulla of the bones of the rabbit. He confirms Löwit as to the analogies between the granulations in these cells and those in the blood-corpuscles of crabs, but he does not feel warranted in stating any opinion as to the chemical nature of the abundant α -substance. He does not regard the cells as globulin-forming. In different rabbits the abundance of the eosinophilous cells varies considerably; thus, in those only 12 days old there were comparatively few, and they increase as the creature grows.

γ. General.

Outlines of Zoology.‡—Mr. J. Arthur Thomson has published a text-book of Zoology, intended to serve as an accompaniment to several well-known works, most of which follow other modes of treatment. The earlier chapters which deal with the general aspects of the subject are more detailed than they often are in English works of this kind.

Fifth Annual Report of Liverpool Marine Biological Station.§—Prof. W. A. Herdman has published another of his lively and interesting reports on this station which is still situated on Puffin Island. The bad weather of last year was very much against the marine zoologist, but progress has been made with the third volume of reports on the Fauna and Flora of Liverpool Bay. Species new to the region continue to be discovered.

B. INVERTEBRATA.

Spermatogenesis of some Mediterranean Invertebrates.||—Dr. C. Pictet has investigated the spermatogenesis of five species of Echinoids,

* Archiv f. Mikr. Anat., xxxix. (1892) pp. 141-50 (1 pl.).

† Op. cit., xxxviii. (1891) pp. 613-8.

‡ 'Outlines of Zoology,' Edinburgh and London, Young J. Pentland, 1892, 8vo, xiv. and 641 pp. (32 pls. of diagrams).

§ Liverpool, 1892, 8vo, 31 pp.

|| Mittheil. Zool. Stat. Neapel, x. (1891) pp. 75-152 (3 pls.).

one Siphonophore (and four more superficially), one Pteropod, one Cephalopod, one Polychæte (*Eteone pterophora*), and *Salpa virgula* among Tunicates. The terminology adopted is that of La Valette St. George.

The general conclusions to which his investigations have led the author are summarily stated. He regards spermatogenesis proper as nothing but the change in form of a cell in a definite way; its object is to fecundate the female cell, and the development of the spermatozoon from the spermatid is only a secondary phenomenon of adaptation which serves to facilitate the meeting of the two cells. The present studies serve to confirm the doctrine that the nucleus of the spermatid forms the head or body of the spermatozoon, and the author believes that in time all animal spermatozoa will be found to have a more or less normally constituted nucleus. This nucleus, however, is not a homogeneous whole or formed of a single substance; we may distinguish in it the nuclein or chromatin and the nuclear plasma or karyoplasma. The relations of these two vary very considerably with the stage of the development of spermatozoa; where kinetic division is going on the nuclein and the karyoplasma are sharply differentiated. Most fixing reagents give a sort of structure to the nuclei, but Dr. Pictet thinks that this structure is only an artificial modification of the nuclear substance. If, as he thinks, the nucleus is dissolved in the karyoplasma, the addition of an acid, which does not dissolve the nuclein, will cause it to be precipitated in a more or less granular form. It is only after the penetration of the spermatozoon into the ovum that the nucleus takes on a structural form to fuse with the female nucleus. The author believes that the karyokinetic division of the spermatocytes has the object of furnishing each seminal cell with a nuclear substance, which has exactly the organic and chemical constitution necessary for fecundation. When, towards the end of spermatogenesis, direct division occurs, its object is that of giving to each spermatid the amount of nuclear substance necessary to the formation of a spermatozoon.

The necessary locomotor organ is provided by the cytoplasm of the seminal cell, which forms what is ordinarily known as the tail of the spermatozoon. The volume of this tail is generally much smaller than that of the cytoplasmic part of the tail that has been used up in forming it; there is clearly a condensation of the protoplasm with the object of giving more rigidity to the caudal filament, and allowing it to resist the movement, often of some violence, by which it is affected.

The cellular membrane may be generally seen easily in young spermatids, where it has the form of a very delicate cuticle, but it disappears as soon as the spermatozoon begins to be formed, and is probably dissolved in the cytoplasm. In the Siphonophora, however, it persists for a longer period.

Dr. Pictet has paid especial attention to the accessory nucleus, which appears to be a corpuscle formed for the purpose of eliminating from the seminal cell the substances which have become useless to the spermatozoon. It is to be borne in mind that the spermatozoon is a ripe cell, which will not give rise to daughter-cells by division. Everything,

therefore, which is needed only for the act of cell-division has no further *raison d'être* in the spermatozoon, and ought consequently to be eliminated. After the last karyokinetic division is effected, there is to be seen in the cytoplasm a certain number of corpuscles which appear to be the remains of bodies which have, during division, been formed from the nuclear plasma of the mother-cell. These are the bodies which Prenant has called cytomicrosomes; as they are useless they should be eliminated, and for this purpose they fuse with the more or less large globules which form the accessory nucleus. Its fate, however, is very variable, in *Eteone* it was seen to become simply detached from the cell; in the *Siphonophora* it persists by the side of the nucleus; in others, as in most *Echinoids*, it forms the median segment of the spermatozoon. So that we may say that, when it is not expelled, it is utilized for the formation of one of the secondary parts of the zoosperm. In any case there is no proof that this corpuscle ought to be regarded as one of the constituent parts of the normal spermatozoon.

Blood and Lymphatic Glands of Invertebrates.*—M. L. Cûénot deals with this subject in great detail. The following are his chief conclusions:—

In almost all animals, if not in all, the blood contains a varying amount of dissolved albuminoid material, which, in Invertebrates, has often both a respiratory and a nutrient function. This result was suspected by Prof. Ray Lankester in 1869. The most important, and the best studied, after hæmogoblin, is hæmocyanin, found in Mollusca and Arthropoda. It is not yet known why it is in some forms replaced by hæmoglobin, but there is some evidence that it is due to the poor oxygenation of the media occupied by the creatures that exhibit this distinction. The author points out the value of the coagulating power of fibrin, especially in those animals that are subject to fracture of their appendages; its presence among Invertebrates is very variable. The Echinoidea are remarkable for the formation by amœbocytes of plasmodia which rapidly become organized and repair fractures of the test; in Starfishes or Holothurians, when the body is sufficiently contractile to close accidental lesions, the amœbocytes only rarely form plasmodia comparable to those of Sea-urchins.

Blood-corpuscles are found in a number of Invertebrates; they contain an oxidizable albuminoid, always have a pretty constant form, and generally contain a granular stroma which may inclose colourless vacuoles. In any given group there are almost always exceptions to the rule that it possesses blood-corpuscles.

Amœbocytes are elements of special importance, and have very various assimilating and nutrient functions. They almost always contain refractive granules, which are more or less abundant, and which the author distinguishes as albuminogenous granules. It is believed that they give rise to the albuminoids dissolved in the blood-fluid. In addition to this assimilative function they often serve as reserve-cells, in consequence of the accumulation of fat and albuminoids in their protoplasm. They form the materials which are always ready to repair

* Arch. Zool. Expér. et Gén., ix. (1891) pp. 13-90, 365-475 593-670 (9 pls.).

damaged or wounded tissues. They are the agents by which resistance is offered to foreign bodies and microbes, while they also absorb sickly or degenerating tissues. It is not right to compare them to *Amœbæ* living in the organism, but rather to take Loewit's view that they are floating unicellular glands. Being adapted to a more or less albuminous medium they are unable to live in water outside the body. The life-history of an amœboocyte is hard, if not impossible, to determine.

The lymphatic glands, however variable in form, are always formed in the same way; there is a connective layer which incloses in its plasma a large number of nuclei; these are surrounded by protoplasm, which is filled with refractive granules; these cells become amœboid and pass by diapedesis through the meshes of the connective tissue to fall into the blood. It is not always easy to find the lymphatic glands of any given animal, and in some cases this is doubtless due to the diffused arrangement which the gland takes on.

Sometimes the lymphatic glands give rise to genital products, either directly or indirectly; but this phenomenon is only well defined in the Echinodermata, and in the Trochozoa.

Wandering Cells and Excretory Functions.*—Mr. H. E. Durham's observations were chiefly made on Echinoderms, but *Dytiscus marginalis* and species of *Unio* and *Anodonta* were also examined. The author commences with a discussion of the fate of insoluble foreign particles; the ingestion of Indian ink in normal salt solution into the abdomen of *D. marginalis* was followed by the appearance of one or more particles in many of the amœboid blood-corpuscles. Then follows a process of encapsulation, by means of which the particles are removed from the circulation.

The next section of the paper deals with the diapedesis of leucocytes containing products of normal metabolism; it seems probable that a process of excretion by means of wander-cells occurs in many animals, and that many of the "mucous" pigment and other cells described in epidermis may really be of the nature of wander-cells, whose onward progress has been stopped by the reagents of the histologist. One factor which may be of importance is the stimulus afforded by the contents of the cell. Inert granules, micro-organisms, pigment concretions and so on may cause the cell to wander further than it ordinarily would.

Results of Indian Deep-sea Dredging.†—Prof. J. Wood-Mason and Dr. A. Alcock report that of the Echinodermata dredged from deep waters in the Indian Sea, the Asteroidea are represented by twenty-three species, fourteen of which appear to be undescribed; *Persiphonaster* is a new genus allied to *Plutonaster*, and is represented by two new species. *Dictyaster* is a new genus of Echinasteridae, for *D. xenophilus* sp. n. Three new species of *Brisinga*—*B. insularum*, *B. bengalensis*, and *B. andamanica*—are shortly defined. The new Echinoids are *Prionechinus Agassizii* and *Homolampas glauca*. Nine genera of Holothurians and seven of Ophiuroids have been recognized but are not described. Of the Crinoids dredged one was a *Eudiocrinus*. Only three Cephalopods were

* Quart. Journ. Micr. Sci., xxxiii. (1891) pp. 81-104 (1 pl.).

† Ann. and Mag. Nat. Hist., viii. (1891) pp. 427-52 (1 pl. and 6 woodcuts).

found, of the nine Gastropods only three have as yet had the species determined. A fine Pennatulid with a rich orange pigment insoluble in alcohol, was taken at about 200 fathoms; several *Umbellulæ* were dredged; a good series was obtained of *Flabellum japonicum*; to a large and interesting Foraminifer the name is given of *Hormosina Bradyi*.

Freshwater Fauna of Iceland.*—MM. J. de Guerne and J. Richard report that M. Rabot, in his recent expedition to Iceland, added twenty-nine species to the freshwater fauna; of these, all of which are already known species, twenty-six were Entomostraca, two Rotifers, and one Protozoon; some of the Crustacea were known from Arctic, and others from temperate waters.

Invertebrate Fauna of Poland.†—Dr. J. Nusbaum reports on various Polish faunistic observations. H. Lindenfeld and J. Pietruszynski‡ record the occurrence of the following Hirudinea:—*Nepheleis octoculata*, *Aulostomum gulo*, *Hirudo medicinalis*, *Clepsine sexoculata*, *Cl. marginata*, *Cl. bioculata*, *Cl. polonica* sp. n., *Piscicola piscium*, *Cl. tessellata*. The variations in colouring seem to have some relation to locality.

Of Rhabdocæla, H. Lindenfeld chronicles eleven species, hitherto unrecorded for Poland,—*Stenostoma leucops*, *Microstoma lineare*, *Macrostoma hystrix*, *Vortex Millportianus*, *V. sexdentatus*, *Gyrator hermaphroditus*, *Mesostoma productum*, *M. personatum*, *M. viridatum*, *Castrada radiata*, *C. sp.* Of Lumbricidæ, *Lumbricus herculeus*, *L. rubellus*, *L. purpureus*, *Allolobophora turgida*, *A. mucosa*, *A. fetida*, *A. subrubicunda*, *A. arborea*, *Dendrobæna Boeckii*, *Allurus tetraedrus*.

Herr A. Lande§ records twenty species of *Cyclops*, including *Cyclops gracilicornis* sp. n., green in colour, and with longer caudal bristles than in all other Cyclopidae, and *C. Dybowski* sp. n., violet in colour, and like *C. hyalinus* Rehnberg.

Fauna of Alpine Lakes.||—Herr F. Zschokke writes the chronicle of a summer excursion to the lakes of the Rhetikon—Garschnia, 2189 m. above sea-level; Partnun, 1874 m.; Tilisuna, 2102 m.; and Linersee, 1943 m. Of the 119 animals which were collected we may notice the following:—*Diflugia pyriformis*, *Actinophrys sol*, *Dinobryon sertularia*, *Epistylis plicatilis*, *Colurniopsis vaga*, *Lagenophrys vaginicola*; *Hydra rhætica*; *Monotus lacustris*, *Planaria alpina*; *Trilobus pellucidus* and five other Nematodes; *Callidina parasitica* and nine other Rotifers; among Oligochaeta, *Sænuris velutina* and *S. variegata*, *Bythonomus Lemani* and *Lumbriculus variegatus*; two species of *Clepsine*; *Lyneceus rostratus*, *Chydorus sphaericus*, *Acroperus leucocephalus*, *Macrothrix laticornis* and other Cladocera; *Cypris compressa* and *C. candida*; *Diaptomus baccifer* and *Cyclops strenuus*; *Niphargus puteanus*; *Sperchon glandulosus*, *Lebertia tau-insignitus*, *Arrenurus maculator*, *Trobidium planum* and other Acarina; *Macrobiotus macronyx*; numerous insects, such as *Nemura variegata*, *Perla alpina*, *Capnia nigra*, *Heptagenia longicauda*, *Sialis*

* Comptes Rendus, cxiv. (1892) pp. 310-3.

† Biol. Centralbl., xii. (1892) pp. 54-8.

‡ Physiographische Denkschrift, Warschau (Polish), ix. (12 pp. and 1 pl.) and x. (1890) 42 pp., 1 pl. and 14 figs.

§ Tom. cit., x. (1890) pp. 90 (7 pls.).

|| Verh. Naturf. Gesellsch. Basel, ix. (1891) pp. 425-508.

lutaria, *Trichostegia variegata*; *Phryganca pilosa*, *Chætopteryx villosa*, *Hydrometra paludum* and *H. thoracica*, *Notonecta glauca*; *Chironomus plumosus*, *Corethra plumicornis*, *Colymbetes congener*, many species of *Hydporus*; among Lamellibranchs five species of *Pisidium*; of Gastropods, *Limnæa truncatula* and *L. ventricosa*; of Polyzoa, *Fredericella sultana*.

Text-book of Invertebrate Embryology.*—Drs. E. Korschelt and K. Heider have published the second part of their "Lehrbuch der vergleichenden Entwicklungsgeschichte der wirbellosen Thiere." In nine chapters they describe the development of Crustacea, Palæostraea, Arachnoidea, Pentastomida, Pantopoda, Tardigrada, Myriopoda, and Insecta. In the last chapter there is a general discussion of the ontogeny and phylogeny of Arthropods. The Crustaceans are regarded, with Dohrn, as derivable from Phyllopod-like ancestors, and these perhaps, as Hatschek suggests, from Annelid types. Nauplius and Zoca are cenogenetic larval forms. The Palæostraea are separated from their neighbours, and the Arachnoidea from other Tracheata.

Mollusea.

Land Molluscan Fauna of British New Guinea.†—Mr. C. Hedley reports on land shells from British New Guinea, and enumerates 110 species, a fair proportion of which are new. In this interesting region these shells fall into four rather distinct geographical divisions; there is an alpine fauna, whose sole known member is *Rhytida globosa*; the region lying between Port Moresby and the Fly river probably gave origin to the tropical fauna of Queensland, the colonists migrating across the dry bed of the Torres Straits. A third province commences at South Cape Island in the west, and includes the eastern extremity of New Guinea, with various outlying islands. The fourth fauna includes the Louisiade, Dentreesteaux, Trobriand, and Woodlark Archipelagoes. In the case of some species each island appears to possess a form, which is generally a variation peculiar to it.

Air-breathing Mollusca of United States.‡—Mr. W. G. Binney has published a fourth supplement to the fifth volume of the report on air-breathing Molluscs of the United States, in which he believes he brings our knowledge of this subject up to date.

Glossary of Molluscan Terms.§—Prof. A. C. Apgar has prepared a glossary of terms used in describing Molluscs which the beginner at the study may find of use.

γ. Gastropoda.

Nervous System and Zoology Affinities of Cypræa.||—M. E. L. Bouvier states that this short memoir is purely topographical, and contains no new fact of even slight importance; those, however, who require the information it contains should consult it. The author takes the opportunity of discussing some of the statements of B. Haller.

* 8vo, Jena, 1891, pp. 309–908 (315 figs.).

† Proc. Linn. Soc. N.S.W., vi. (1891) pp. 67–116 (5 pls.).

‡ Bull. Mus. Comp. Zool., xxii. (1892) pp. 163–204 (4 pls.).

§ Journal New Jersey Nat. Hist. Soc., ii. (1891) pp. 155–60.

|| Ann. Sci. Nat., xii. (1891) pp. 15–37 (1 pl.).

The Genital Organs of the Genus *Helix*.*—Herr O. Schubert refers to the reproach often hurled at conchologists, "that they treasure the shell and throw away the contents," and submits this research in evidence that "malakologists" are now wiser than their forbears. For he has studied the genital organs (and more than these) of scores of species of *Helix*, justifying his research and also the conchological classification. On anatomical grounds, he confirms the distinctness of most of the species in Kobelt's catalogue. It is true that *Helix personata* Lam. cannot, on "malako-zootomical" grounds, be retained in the sub-genus *Anchistoma*, but must be referred to the *Campylea* type; and there are some other results of the same nature. Herr Schubert chronicles not a few local variations of the same species, not only in their genital parts, but also in other characteristics. He also notices many microscopic features hitherto unobserved, and gives for the first time an anatomical diagnosis of many species.

Innervation of Epipodial Processes of Nudibranchs.†—Prof. W. A. Herdman and Mr. J. A. Clubb find that the innervation of the ceratal processes is not the same in all Nudibranchs. In *Polycera*, *Arcula*, *Tritonia*, and *Dendronotus* the epipodial nerves arise from pleural ganglia or from the ventral and posterior parts of cerebro-pleural masses. In *Eolis*, on the other hand, the chief epipodial nerves are from the pedal ganglia, but there are also smaller nerves from the pleurals.

Organization of some French Neomeniæ.‡—M. G. Pruvot gives a large number of details as to the organization of some French Neomenians, but declines to enter into any general considerations till a knowledge of their embryology has been acquired. The author has been so fortunate as to discover several new forms of this group on the French coast, and we drew attention to his discovery at the time §; a table by which the various genera and species may be distinguished is now given.

It is, of course, impossible to follow the author through all his anatomical details, but we may draw attention to one or two points. Contrary to most anatomists he believes that the genital ducts are completely uninterrupted in their course, and that they are entirely distinct from the general cavity. The longitudinal nerve-trunks present some variations in the manner in which they end, and there is not the difference between *Neomeniæ* and *Chætoderma* as was formerly supposed. *Proneomenia vagans* has a copulatory organ similar to that of *Neomenia carinata*, save that it has lost all connection with the rest of the genital apparatus, and serves only as an organ of excitement.

Molluscoida.

a. Tunicata.

Larvæ of Ascidians.||—Herr Hartmann gives a brief account of the larvæ of *Ascidia patellæformis*. He compares what he cautiously calls "the (noto-) chord-like strand in the tail" with the notochord of *Amphi-*

* Arch. f. Naturgesch., lviii. (1892) pp. 1-65 (6 pls.).

† Rep. Brit. Ass., 1891 (1892) pp. 692-3.

‡ Arch. Zool. Expér. et Gén., ix. (1891) pp. 699-805 (7 pls.).

§ This Journal, 1890, p. 581.

|| SB. Gesell. Nat. Freunde Berlin, 1891, pp. 4-7.

oxus. In one case he convinced himself of the presence of two eye-spots, which were quite apart from the otoliths.

New Genus of Synascidians.*—Messrs. Asajiro Oka and A. Willey describe a remarkable compound Ascidian from Misaki, Japan, which they propose to call *Sarcodidemnoides misakiense*. It is one of the Didemnidae and is allied to *Didemnoidea*. It is characterized by the colony forming very thick, lobose masses, laterally composed; though sessile, it is not encrusting. It has a number of knoll-like prominences, on the tips of which are placed the excurrent orifices. The ascidiozooids are very numerous, but are not arranged in systems; the complicated canal system is differentiated into peripheral and central portions. In colour it is brilliantly red. The larvæ are large and tailed—a characteristic of the family. In the superficial region of the test there is a thin layer of extremely delicate calcareous spicules; though they vary in form the crenate is the most common; they are best seen in sections which have been mounted unstained. The surface of the test consists almost entirely of large bladder-cells which are usually rendered polygonal by mutual pressure, but when they contain crystals they are invariably perfectly round. The cells below the bladder are fusiform in shape.

New Form of Appendicularian "Haus."†—Mr. G. Swainson describes briefly a new form of "haus," which was shaped very like a bishop's mitre. He agrees with Prof. Allman in the opinion that the main function of this curious structure is to serve as a nidamental covering for the ova; the sac is probably a primitive test, and can be jerked off the *Appendicularia* by a vigorous contraction.

B. Bryozoa.

Nature of Excretory Processes in Marine Polyzoa.‡—Mr. S. F. Harmer was led to a study of the physiological meaning of the periodic formation of "brown bodies" in Ectoproctous Polyzoa, by Kowalevsky's studies on excretion in various Invertebrates. His experiments with artificial pigments confirm the view that the marine Ectoprocta are not provided with definite nephridia, and appear to show that the excretory processes are carried on principally by the "brown bodies," the funicular (connective) tissue, and the free mesoderm cells contained in the meshes of the latter.

On account of their transparency and abundance at Naples, Mr. Harmer principally observed *Flustra papyrea*, *Bugula neritina*, and *B. avicularia*. Each was exposed to the action of indigo-carmin, carminate of ammonia, and Bismarck-brown, and was placed in sea-water containing carmine powder in suspension. The colonies were thence transferred to pure sea-water.

One of the author's most interesting results has been the observation of the fact that the tissues of different forms, even of two species of the same genus, do not necessarily react in the same way to the action of the same pigment; the taking up of the pigment by particular

* Quart. Journ. Micr. Sci., xxxiii. (1892) pp. 313-23 (2 pls.).

† Rep. Brit. Ass., 1891 (1892) pp. 701-2 (1 fig.).

‡ Quart. Journ. Micr. Sci., xxxiii. (1891) pp. 123-67 (2 pls.).

tissues may have a definite relation to the normal pigmentation of those tissues. These facts tend to confirm the conclusion to which Dr. Eisig has been led, that the normal pigments are to be interpreted as, to a considerable extent, excretory in nature.

The author commences his descriptive portion with an account of the normal characters of the living zoëcium in the species investigated, and then describes the process of absorption of various pigments. In his third section he deals with the formation of the "brown body," and the further history of the absorbed pigments.

Leucocytes readily absorb indigo-carminé; they do not take up Bismarck-brown directly, but abstract it at a later period from other tissues; they are not in the least affected by carminé in suspension, or by carminate of ammonia. The pigmented granules of the stomach and cæcum of *Bugula avicularia* readily take up indigo-carminé, carminate of ammonia, or Bismarck-brown, while the same parts of *B. neritina* are quite unaffected by the first and last of these pigments. The funicular tissue of *B. neritina* is deeply pigmented and readily takes up Bismarck-brown; in the other form investigated this tissue was generally colourless, and did not take up Bismarck-brown in the manner characteristic of *B. neritina*. Young, slightly differentiated tissues of growing points readily take up considerable quantities of carminate of ammonia and of Bismarck-brown.

The author, before proceeding to consider the corroborative work of other observers, points out that it can hardly be doubted that the pigments experimented with were actually excreted. In *B. neritina* Bismarck-brown was taken up so freely by the funicular tissue that it at first appeared extremely improbable that the animals could recover, but at a later period the pigment was deposited in an apparently insoluble form in various parts of the funicular tissue, the remainder of which was quite free from it. Similarly the alimentary canal of *B. avicularia* was able to rid itself of Bismarck-brown by a process which involved the loss of its normal granules, inclosed in spherules. Such spherules are of normal occurrence in this species, and are probably concerned in the excretion of some of the normal pigments of the canal, though their function may be in part digestive.

Polyzoa of the St. Lawrence.*—After an interval of three years the Rev. T. Hincks continues his study of Arctic forms. *Flustra solida* Stimpson is discussed at some length. *Membranipora annifera* Hincks was, it now appears, first described from immature specimens; the author now revises and completes the diagnosis from perfect forms. Nine other forms are more or less briefly discussed.

Arthropoda.

a. Insecta.

Swimming Butterflies.†—Prof. S. Klemensiewicz tells, under this more sensational than accurate title, how he watched white butterflies (*Pieris rapæ*) fluttering in hundreds over the great lake of Czarny Staw, Many sank on the still surface of the water, rested for half a minute,

* Ann. and Mag. Nat. Hist., ix. (1892) pp. 149-57 (1 pl.).

† Verh. Zool.-Bot. Gesell. Wien, xli. (1891) p. 87.

and flew again upwards. But some rested too often, for when the wings became thoroughly damped, those which rested on the surface never rose again. But we find no account of swimming butterflies.

Mimicry.*—Dr. E. Haase continues his elaborate memoir on the mimicry and systematic relations of Papilionidæ. In the present instalment, he begins with a short history of the theory of mimicry, from the use of the term by Kirby and Spence in 1816, down to the present day. In illustration of mimicry between plants he calls attention to the resemblance between *Cerastium semidodecandrum* var. *tetrandrum* and the Crucifer *Cochlearia danica*. Among lower animals no certain cases of mimicry are known, and that alleged by Bovallius to exist between the Crustacean *Mimonectes* and a Craspedote Medusa is not very convincing, since the Crustacean seems to be only occasionally a surface form. Among Arachnida, however, there are some good examples, as Bates, Belt, E. G. Peckham and others have shown. Herr Haase then passes to insects, and describes examples of mimicry among Orthoptera.

Male Generative Organs of Honey-Bee.†—Mr. G. Koschewnikoff finds that all existing descriptions of the male generative organs of the Honey-Bee are either incomplete or incorrect. The testis has two envelopes; the outer, which is formed by the fat-body, has two kinds of cells; some are large and flat and have elongated flattened nuclei; others are irregularly spherical and resemble the cells of the fat-body which contain the fat-drops. The inner coat is of the nature of connective tissue, and is divisible into two layers. The seminal tubules are surrounded by a fine fibrous investment which contains elongated nuclei, and they open into a reservoir placed in the interior of the testis. Tracheæ are to be found in the substance of the testis. The whole testicle of the Bee corresponds to a portion only of that of such a type as *Bombyx mori*. The vas deferens is given off from the reservoir, forms loops in and outside of the testis, and passes to the seminal vesicle. The epithelial cells of this last are elevated, arranged in circular ridges, and glandular in nature. The muscles are set circularly within, and longitudinal without. The canal into which the vesicle narrows does not open into the ductus ejaculatorius but into the glandulæ mucosæ; its epithelial cells are much vacuolated and have, therefore, a spongy appearance. The cæca described and figured by Leuckart are really torn muscles which are attached to the ventral wall.

The ductus ejaculatorius is inserted by two chitinous branches into the point of union of the two glandulæ mucosæ; it and the whole copulatory apparatus are devoid of muscles, which are, however, well developed beneath the mucous glands. From the end of the ductus ejaculatorius to the outer opening of the generative apparatus, we have a continuous chitinous sac with various evaginations, folds and thickenings. In its upper part there are attached to it two pairs of large chitinous plates, the chitin of which has a distinctly granular structure. The succeeding part is so strongly chitinized that no trace of epithelial cells is to be seen; this chitin is closely covered with thick unbranched hairs directed inwards, and larger and thicker at the points where the chitinous

* Bibliotheca Zool., viii. (1891) Heft 3, pp. 1-8 (4 pls.).

† Zool. Anzeig., xiv. (1891) pp. 393-6.

wall forms folds and evaginations. They have never yet been properly described, and the details are too numerous for mention in the author's present, preliminary notice.

The Palps of Rhynchota.*—Herr E. Schmidt finds palps on the underlip of *Nepa* and *Ranatra*, yet the absence of these palps is usually stated as characteristic of Rhynchota. He finds that various entomologists, from Savigny onwards, have noticed these structures, but their homology has not been recognized. The author also discusses the systematic relations of *Nepidæ* and *Belostomidæ*, and concludes that they are more nearly related to one another than to any other group.

Embryonic Development of *Phyllodromia germanica*.†—Herr N. Cholodkowsky has been for four years engaged in the study of the development of *Phyllodromia (Blatta) germanica*, and here exposes some of his results. With regard to those of most general interest we may note that he finds that the head of Insects contains more than four protozonites, and probably six, one of which is pre-oral and the others post-oral. The antennæ belong to the first post-oral segment and are completely homologous with the other ventral extremities; they do not correspond to the antennæ of *Peripatus*, but rather to the chelicerae of Spiders, and perhaps to the second pair of antennæ in Crustacea. As the possibility that a number of segments in the germ-stripe of various Arthropods have disappeared cannot be denied, it is at present impossible to speak definitely as to the homology of the mouth-parts of the various classes of Arthropods. The abdominal appendages of the insect germ-stripe (cerci included) are homologous with the thoracic legs. It is not important whether they are attached to the middle, side, anterior or posterior margin, so long as their cavity is directly continuous with the cavity of the somite to which they belong. The fact that the abdominal appendages are generally unjointed is not an argument against their being appendages, for, e. g. the mandibles are always unjointed. Many of the abdominal appendages of larval and imaginal insects are homologous with thoracic legs, although they are ontogenetically secondary.

The primitive function of the first pair of abdominal appendages was, like that of the rest, ambulatory, and we may be sure that the ancestors of Insects were homopodous and not heteropodous. The poly-podous Insect-larvæ are no more to be derived from the hexapodous than they from the polypodous; the two forms were developed independently of one another. The embryonic investments of Insects probably correspond to the remains of the trochophore. The author is inclined to believe in the, at least, diphyletic origin of the Arthropoda; the Crustacea are characterized by their naupliiform larva, while there is a striking likeness between the embryonic development of Insects and *Peripatus*; the ancestry of the former would be found among the Marine Annelids with a trochophore stage, and of the latter among terrecolous or freshwater and more oligochaete-like worms. He expresses great doubts as to the relationship of the Marine Pœcilopoda with the terrestrial Arachnoidea.

* SB. Gesell. Nat. Freunde Berlin (1891) pp. 46-54.

† Mem. Ac. Imp. Sci. St. Pétersburg, xxxviii. No. 5 (1891) 121 pp. (6 pls.).

A comparison of the various modes of yolk-cleavage in Insects leads the author to believe that, in the great majority, there is a partial centrolecithal segmentation. After this true cleavage is ended there may be a secondary fragmentation of the nutrient yolk. Primitively the Insect's egg was proportionately very poor in yolk and segmentation was total, as it is to-day in the Poduridæ.

In the cleavage of certain eggs there are formed cells or nuclei which do not range themselves in the germinal layers; these may be collectively known as the parablast; it consists of non-specialized cells and may be of different significance in different animals, and it is not necessary to suppose that it is always present. There is no doubt that those tissues which in some animals are of parablastic origin are in others derived from the germinal layers. The parablast is chiefly found in meroblastic ova.

Development of Female Reproductive Organs of the Cockroach.*
—Dr. R. Heymons has studied this in *Phyllodromia* (*Blatta*) *germanica* L. In early stages of development, some mesoderm cells become genital cells, and after the formation of the coelom sacs more mesoderm cells, which form an epithelial sheath around part of the coelome, are similarly modified. Thus the origin of the genital cells is essentially the same as in Annelids, and it is likely that in all insects the genital cells have this mesodermic origin. The terminal thread is important only during embryonic and larval life, during which it has to do with the changes in the position of the ovaries. In the cockroach the genital cells and the epithelial cells of the ovaries are from the first independent. Isolated genital cells appear in the blastoderm long before there is any connected genital rudiment associated with epithelial cells. When the genital cells migrate to the dorsal walls of the primitive segments, then for the first time epithelial cells become associated with them. During the whole of development the two sets of cells are distinct, even in the terminal chambers of the ovarian tubes. So far as in higher insects "indifferent cells" really occur in the terminal chambers, it is simply due to the fact that the differentiation of mesoderm cells into genital and epithelial, which occurs very early in the cockroach, is of late occurrence in these other insects.

Digestive Canal of Orthoptera.†—Sig. O. Visart has studied the mid-gut (meso-intestine) of *Acridium*, *Ædipoda*, and other Orthoptera. In the epithelium there are cylindrical cells with a border, much elongated clavate cells without a border, and quite distinct large oval cells. The cylindrical cells represent the quiescent stage of the very actively secretory elongated cells. The same two types occur in the glandular cæca. A careful description of the border or plateau of the cylindrical cells is given. In the clavate glandular cells the nuclear division is amitotic and of the nature of fragmentation. In the secretory process the nucleus sometimes remains apparently indifferent and basal in position; but when there is a supplementary anterior nucleus it undergoes chromatolysis and is dissolved in the secretory "gemination." The same cell may exhibit secretory gemination several times. Some-

* Zeitschr. f. Wiss. Zool., liii. (1891) pp. 434-536 (3 pls.).

† Atti Soc. Tosc. Sci. Nat., vii. (1891) pp. 277-85.

times instead of gemmation there occurs what may be called a secretory segmentation, the anterior portion of the cell being divided off and the contents extruded through an aperture in the wall.

Autotomy in Grasshoppers.*—Dr. F. Werner finds that *Ephippigera vitum*, *Barbitistes serricauda*, *Saga serrata*, and occasionally *Locusta viridissima*, amputate their limbs. When *Barbitistes serratus* is captured it bites off its anterior legs by the root; when the others are kept in captivity they proceed to eat off the tarsi or even as much as half of their appendages. In the case of *Mantis* a destruction of the tarsi was noticed, but the herbivorous *Aceridiidæ* and *Gryllodidæ* are not known to exhibit this strange freak.

Spirally-coiled Cases of Insect Larvæ.†—Dr. E. von Martens discusses the resemblance between *Cochlophora valvata* and the Gastropod *Valvata*. His specimens were collected by Stuhlmann on his journey with Emin Pasha, and no species of *Valvata* occurs in the region where they were found. Moreover the *Cochlophora* measured 10-11 mm. in height by 11-12 in breadth, and had three or four coils, while no species of *Valvata* even half as large is known. The habitat of the Gastropod is in water, that of the insect larvæ on dry land. There is no mimetic relation between the two. The spiral coiling of the insect's case is a convenient independent adaptation.

In Stuhlmann's collection twenty specimens were coiled to the right, and twenty-two to the left. It is of interest therefore to inquire into the direction of the spiral in similar insect larvæ. Von Martens finds that in thirty-one specimens (or records) of *Psyche* or *Cochlophora helix*, not one was coiled to the right; that *Psyche Planorbis* is also coiled to the left; and that in numerous forms of aquatic origin (*Phryganidæ*) all but one were coiled to the right. The East African spiral cases are remarkable in having a homogeneous texture. Finally von Martens refers to that Phryganid case which Lamarek called *Dentalium nigrum*, and to *Paludina lustrica* Say, *Dentalium corneum* L., and *D. pellucidum* Gmel., which are sometimes ranked as cases of insects, but which are not, the first being a Gastropod, the others tubes of Annelids.

δ. Arachnida.

Protective Colour of Spiders.‡—Herr M. Bartels describes the protective nature of the colour in *Epeira diademata* (yellowish-grey, orange-yellow, orange-red) as observed in forms living among juniper bushes. "The coloured abdomen was scarcely distinguishable from the yellowish-red twigs," and so on. He also notices that the startled spiders seek safety by dropping from the branch on to the ground.

ε. Crustacea.

Crustacean Blood-corpuscles.§—Mr. W. B. Hardy gives an account of the blood-corpuscles of *Astacus* and *Daphnia*. In a drop of blood taken from a well-fed *Astacus*, a large number of actively amoeboid

* Zool. Anzeig., xv. (1892) pp. 58-60.

† SB. Gesell. Nat. Freunde Berlin (1891) pp. 79-85.

‡ Tom. cit., pp. 1-4.

§ Journal of Physiology, xiii. (1892) pp. 165-90 (1 pl.).

corpuscles, characterized by the possession of numerous extremely large, highly refractive spherules, may be seen. In addition there may be seen a number of large, distinct, rounded nuclei floating freely in the plasma. These belong to blood-cells which are markedly distinct from the spherule-bearing corpuscles, and characterized by such extreme sensitiveness to certain stimuli that contact with a foreign body, such as glass, causes an explosive disruption of their protoplasm. These cells, which the author proposes to call "explosive corpuscles," can be fixed by osmic vapour or iodine. The spherule-bearing cells are identical with Ehrlich's eosinophile granules, and are to be called by his name. The average number of corpuscles in a cubic millimetre of blood is 286, but the variation is between 250 and 400. The normal ratio of granular to explosive cells is one to three.

The explosive cells may be seen to undergo remarkable changes; extremely fine pseudopodia are shot out, along which blebs of cell-substance rapidly travel, expand into a bubble, and burst. Sometimes only short blunt processes are formed, and sometimes the surface of the cell forms vesicles without processes. In any case there is an explosive solution of the cell-substance. Meantime, the nucleus also suffers remarkable changes; at first indistinct, it rapidly acquires distinctness, and changes which appear to be of a clotting nature go on. The average dimensions of an explosive corpuscle appear to be $25-30\ \mu$ in the long, and $10-11\ \mu$ in the short axis.

The eosinophilo corpuscles, on the other hand, persist unchanged and may even retain their powers of movement for a long time, in a drop of blood, placed under a coverslip. They exhibit a marked distinction into ectosare and endosare; they vary greatly in shape, and the number of the granules in the endosare also varies considerably. The granules are extraordinarily refractive and very large, but they are not, as Haeckel thought, fatty. The author sets out at length the histological characters of the eosinophile cells, partly because it is necessary to do so to show that the explosive, eosinophile and basophile (to be mentioned immediately) cells differ not merely in the kind of granules they produce, but in the very nature of their cell-substances.

The basophile cells, to use Ehrlich's name, are those whose spherules have a profound affinity for basic pigments such as methylene or methyl-blue. They are very rare in the normal Crayfish, but are always found if the animal has been poisoned by certain substances; in *Daphnia*, on the other hand, they are commonly present in the blood-stream. In the Crayfish they are, normally, important constituents of the special and peculiar tissue which forms a thick external sheath to some of the arteries; they are large (as much as $65\ \mu$ by $37\ \mu$) and irregular.

The most striking fact with regard to the blood-corpuscles of *Daphnia* is that they are extremely generalized and primitive in their characters; there is no sharp distinction into two kinds of blood-cells, and they perform functions which, in the higher animal, are relegated to cells which are no longer wandering. It is of importance that we can regard the blood-cells of the more specialized type as a specialized tissue, or tissue sharply defined morphologically, and, probably, also possessed of equally sharply defined physiological characteristics. Each blood-cell of *Daphnia* includes within itself the characteristics of the explosive

and eosinophile blood-corpuscles, and of the basophile cells of the cell-tissue of *Astacus*. They also all of them may, under appropriate conditions, ingest solid masses.

Persistent Nauplius Eye in Decapods.*—Miss M. Robinson has observed the persistent nauplius eye in *Palæmon serratus*, *Virbius varians*, and *Pandalus annulicornis*. On removing the rostrum from a fresh specimen the median eye can be seen as a black speck lying in the centre of the triangle formed by the brain and the stalks of the lateral eyes. The brain is covered by chitin, which is lined by a thin layer of ectoderm; if the dorsal part of this and a small piece of the anterior portion of the brain be removed, the eye can be seen lying in a blood-space just dorsal to the brain. It has the appearance of a black)(which is slung on to the ectoderm by two slender threads which swell out in the concavities formed by the arms of the)(, and then narrow again as they approximate to each other.

The)(consists of two large pigment cells and the supporting strings are formed partly of ectoderm, and partly of club-shaped nerve-end cells. No trace of a refractive body could be found within the eye. On the whole the resemblance to the median eye of *Branchipus*, as described by Claus, is very close. This eye has been observed in the adults of eight species of Carididæ.

Abnormalities in *Astacus fluviatilis*.†—Prof. W. N. Parker has a notice of three abnormal Crayfishes. In one there was a small but well developed pleurobranch on the wall of segment xii. in place of the usual rudimentary style; the normal pleurobranch on segment xiii. was present. In another the last arthrobranch on the left side was forked; the bifurcation began close above the base, and the two branches were nearly equal in size. The third specimen exhibited a partial fusion of the fourth and fifth abdominal segments; the calcified sternal bars were completely fused from the middle line nearly to the attachment of the appendage on the right side.

New Family of Schizopoda.‡—Prof. P. J. Van Beneden describes a new Crustacean from the Azores for which he proposes the name of *Cryptopus Defranci*, and for which it is necessary to establish the new family Cryptopodidæ. It appears to be allied to the Isopoda, while its Schizopod affinities are most with the Euphausidæ, for, like them, it has no marsupium, and exhibits metamorphosis.

British Species of Fresh-water Cyclopidae and Calanidae.§—Prof. G. S. Brady has published a useful and richly illustrated revision of these species, the discrimination of which offers very considerable difficulties; in all cases it is necessary to dissect and examine under high powers of the Microscope very large numbers of specimens.

* Quart. Journ. Micr. Sci., xxxiii. (1892) pp. 283-7 (1 pl.).

† Ann. and Mag. Nat. Hist., ix. (1892) pp. 181-2.

‡ Bull. Ac. Roy. Belg., lxi. (1891) pp. 444-59 (1 pl.).

§ Nat. Hist. Trans. Northumb., Durham, and Newc., xi. (1891) pp. 68-120 (14 pls.).

Vermes.

a. Annelida.

Development of Nereis Dumerilii.*—Dr. C. v. Wistinghausen finds that the cleavage of the egg of this Polychæte is total and unequal; the ovum divides into four cleavage-spheres. At the animal pole four micromeres of equal size—the encephaloblasts—are constricted off. From these the cephalic ganglion and all the sensory organs of the head are developed. Three cleavage-spheres of equal size give off by constriction six micromeres, and from the largest sphere two large cells are given off—the somatoblasts; from these the trunk, with the exception of the mid-gut and epidermis, is developed. The six micromeres do not take part in forming the organs, but only form the epidermis and the larval prototroch.

The embryonic body is composed of two completely divided foundations; of the ventral, which is formed from the descendants of the two somatoblasts, and of the cephalic lobes which arise from the four encephaloblasts. Union of these two foundations is secondary merely. Development is direct.

Sensory Nerves of the Earthworm.†—Prof. M. von Lenhossék, following Golgi's technical method, has made an important contribution to our knowledge of the nervous system of the earthworm. In *Lumbricus*, the sensory nerve-cells, which, like the spinal ganglion-cells of Vertebrates, give origin to peripheral sensory fibres, do not lie in the nerve-cord, nor in special ganglia, but occur in the skin. Thence each fibre extends to the nerve-cord and sinks into it, dividing in a Y-shaped fashion into an ascending and a descending branch, which extend longitudinally without further division, and end freely in the nearest ganglion. Lenhossék describes the supporting cells, mucus-cells, and nerve-cells of the epidermis; the mucus cells are but slightly modified supporting cells. So abundant are the nerve-cells that the skin may be described as a diffuse sense-organ. All the nerve-fibres which arise from the skin of a segment enter the corresponding ganglion, and the distribution is bilaterally symmetrical. From skin to nerve-cord the fibres retain their individuality, and are almost without lateral branches. Most of them bifurcate in the nerve-cord, but the fibres entering on one side keep to that side. They end freely, and their length within the cord is such that they functionally command three ganglia. Lenhossék has thus been able to demonstrate a close parallelism between the nervous systems of Vertebrate and Invertebrate animals.

Earthworms of Vienna Museum.‡—Mr. F. E. Beddard has a report on the collection of Earthworms preserved in the Vienna Museum, which he has had an opportunity of examining. The most important portion of the collection consisted of the types of Schmarda's species. Mr. Beddard finds that *Hypogæon heterostichon* should be placed in the genus *Anteus*; descriptions are given of the three known species of that genus, the affinities of which appear to be mostly with *Rhinodrilus*. *Perichæta leucocycla* turns out to be *Megascolex cæruleus*. *Perichæta*

* Mittheil. Zool. Stat. Neapel, x. (1891) pp. 41-74 (2 pls.).

† Arch. f. Mikr. Anat., xxxix. (1892) pp. 102-136 (1 pl.).

‡ Ann. a. d. Mag. Nat. Hist., ix. (1892) pp. 113-34 (1 pl.).

cingulata and *P. brachycycla* should both be placed in the genus *Megascolex*. *Diachæta littoralis*, *Perichæta vitiensis* from Viti, and *Acanthodrilus Schmardei* from Queensland are described as new species. Pending a revision of the Cryptodrilidæ, *Hypogæon orthostichon* is placed in the genus *Megascolides*.

Acanthodriloid Earthworms from New Zealand.*—Dr. W. B. Benham gives an account of his observations on two Acanthodriloid Earthworms. The first described is the *Neodrilus monocystis* of Beddard, whose description he confirms and extends; each anatomist had but one specimen, and Dr. Benham pertinently remarks, in connection with the curious fact that in so many cases only one worm is found which serves as the type of a new genus, that some of these may be hybrids or abnormalities. The other form is the representative of a new genus and species which the author calls *Plagiochæta punctata*, and two specimens of it were obtained by Mr. Vaughan Jennings, the collector of these worms.

The generic name refers to the fact that the setæ are always seen crossing the body, and at a first glance it might be thought that one had to do with a *Perichæta*. With that worm, indeed, the new form seems to have some affinities, but here the setæ are arranged in couples, and the details of the internal anatomy are very different. Affinity is shown to *Acanthodrilus* in the position of the male pores, the character of the prostates, and the presence of sacs containing penial setæ. It must rank as one of the Acanthodrilidæ.

Aquatic Oligochæta.†—Dr. W. B. Benham commences this set of notes with observations on the anatomy and histology of *Heterochæta costata*, a worm briefly diagnosed by Claparède some thirty years ago, and never noticed since. It was found by Mr. Shrubsole off Sheerness. The worms, when mature, are about $5/8$ in. long, and pink in colour; it may be recognized by the fan-shaped bundles of dark palmate setæ on segments v. to xiii. After a careful description of its anatomy the author compares *Heterochæta* with other Tubificidæ; it stands nearest to *Psammoryctes*. A useful summary is given of the generic characters of English aquatic Oligochæta.

Spirosperma ferox Eisen, hitherto found only in Sweden, has been found in the Thames and in the Cherwell. It is easily recognized by the naked eye, on account of its grey colour, with a bright white clitellum; the worm is $6/8$ in. long; the chief anatomical point is that the setæ of the dorsal bundles throughout the body are capilliform, and they are, in most cases, accompanied by extremely delicate webbed setæ.

Stylodrilus Vejdoskyi is a new species, taken just below Goring-on-Thames; the description is largely comparative between it and the two other known species of the genus.

Development of Hirudinea.‡—Prof. R. S. Bergh remarks that Herr Apáthy, in his studies on the development of Hirudinea, has not noticed in the Gnathobdellidæ the presence of the provisional larval muscles nor recognized the larval skin as such, and that he is confused in regard to the teloblasts.

* Quart Journ. Micr. Sci., xxxiii. (1892) pp. 289-312 (2 pls.).

† Op. cit., xxxiii. (1891) pp. 187-218 (3 pls.).

‡ Zool. Anzeig., xv. (1892) pp. 57-8.

Onchnesoma Steenstrupii.*—Mr. A. E. Shipley states that the anatomy of this, the smallest of Sipunculids, is more simple than that of other members of the group. The head is much simplified, for there are no tentacles, hooks, collar, eyes, or pigment in the skin; there is no vascular system, no spindle-muscle, and no giant-cells in the brain. The retractor muscle is single, as is also the nephridium, and the brain is not bilobed. Whether this state of things is rudimentary or vestigial we cannot decide till something is known of the development of this worm; perhaps some characters are of one, and others of the other kind.

Mr. Shipley is of opinion that the tentacles and closed vascular system, when present in Sipunculids, are not of importance for respiration, but that the vascular system extends the tentacles, which, on their side, create currents which bring food to the mouth. The chief respiratory organ is probably the intestine, for it has very thin walls, and exposes a large surface to the coelomic fluid which bathes all the organs of the body except the brain.

β. Nemathelminthes.

New Genera of Nematodes.†—Mr. N. A. Cobb finds a genus *Onyx* for a round worm allied to *Dorylaimus*, which he calls *O. perfectus*; it is common in the Bay of Naples. One of its characteristics is the possession of a pharyngeal bulb, the function of which is, by longitudinal contraction, to protrude the contained spear. The action—somewhat unique—of the various organs of the head and neck during feeding is as follows:—The lips are thrust forth and applied to the organism whose juices are to be sucked; the lips are made to adhere by suction exerted in the muscular posterior portion of the oesophagus. The spear is made to glide forward through its guide, and to pierce the surface held by the lip. Suction and swallowing are effected by means of the muscular posterior oesophageal swelling. A distinct muscular bulb is unknown in *Tylenchus*, *Aphelenchus*, *Dorylaimus*, or other spear-carrying genera.

The new genus *Dipeltis* is found for *Enoplus cirrhatus* of Eberth and two new species found at Naples and off Ceylon. The peculiar oral plates described by Eberth are really a hitherto unknown form of the lateral organs; each is an ellipsoidal structure nearly as wide as the head, and with a thickened margin. The author takes the opportunity of describing *Dorylaimus latus* sp. n. found in roots and stems of grass at Sydney.

American Intermediate Host of Echinorhynchus gigas.‡—Dr. C. W. Stiles remarks that *Melolontha vulgaris* and *Cetonia aurata*, the two insects that, in Europe, are regarded as the intermediate hosts of *Echinorhynchus gigas*, are absent from America, and yet the parasite is frequently found in American hogs. By feeding the grubs of *Lachnosterna arcuata* with the eggs of the *Echinorhynchus*, he caused them to be infected with numbers of larval Echinorhynchi; from one grub he took no less than 300 parasites six weeks after feeding. All the grubs examined before the feeding experiment were free from the para-

* Quart. Journ. Mier. Sci., xxxiii. (1892) pp. 233-49 (1 pl.).

† Proc. Linn. Soc. N.S.W., vi. (1891) pp. 143-8 (6 figs.).

‡ Zool. Anzeig., xv. (1892) pp. 52-4.

site. Since making the experiment Dr. Stiles has learnt that it is the custom among many American farmers to make use of their hogs to rid their grounds of these grubs. It is quite possible that of the 91 known American species of *Lachnosterna* others as well as *L. arcuata* may serve as intermediate hosts for the same parasite. It has been objected that *Melolontha vulgaris* is a phytophagous insect, and so also is *Lachnosterna*, but as the plants which they affect are the tender shoots found under manure patches, it is easy to see how they may become infected.

γ. Platyhelminthes.

Nervous System of Nemertinea.*—Herr O. Bürger gives an account of his further investigations into the nervous system of Nemertines. He has been able to convince himself of the presence of unipolar ganglion-cells, the process of which he followed into the central substance, where he saw the fibre mix with the central cord, and then pass into the dermo-muscular tube. His views as to the neuro-chord are somewhat altered, for he believes that even in unarmed forms it represents a single axis-cylinder which does not divide into several.

Though the ganglion-cells of Nemertines are, like those of *Astacus*, unipolar, there are some differences. In *Astacus* the (relatively few) secondary processes arise only in the more proximal portion of the trunk process, while in *Cerebratulus* their origin is more extensive, and there are, consequently, a number of them. The secondary group of *Cerebratulus* has only very fine granules, and is thereby markedly distinguished from *Astacus* where the branches have relatively well developed thickenings. Like *Astacus* and *Homarus*, *Cerebratulus* has nerve-fibres, the sheath of which is devoid of myelin, and has constrictions externally to which nuclei are set. The nerve-fibrils to the muscular fibres of *Drepanophorus* branch in just the same way as the nerve-fibres which go to the thoracic muscles of the Crayfish are figured by Retzius as branching. The dotted central substance of the lateral trunk of *Cerebratulus* is, in structure, essentially different from that of the ventral medulla of *Astacus*; there is a striking preponderance of connective-tissue in the lateral trunk, and there is not the same mode of branching of the secondary processes.

On the whole, however, the similarity in structure between the nervous elements of *Homarus* and *Astacus* and of the Nemertinea is very great, though the arrangement is, of course, different.

The author observed, in the Nemertinea, cells intercalated between the nerve-fibre and the epithelial cell which it innervated. Similar cells may often be detected, after maceration, in all groups of animals, and have been variously named—nucleus, ganglion-cell or nerve-cell; they should be always called nerve-cells, and never ganglion-cells, for these are fundamentally different structures. The nerve-cell is to be regarded as a cell which conveys the stimulus and has no power of independent reaction; a ganglion-cell, on the other hand, is stimulated at one end of a path, and only stimulates if it communicates with other ganglion-cells. There is no evidence in the Nemertinea of a double origin of the nerves.

* Mittheil. Zool. Stat. Neapel, x. (1891) pp. 206-54 (2 pls.).

Two kinds of nerve-fibres which it is impossible not to distinguish are regularly given off from the lateral trunk; each kind can be followed as far as the ganglion-cell. It is easy to suggest that the thin fibres are sensory, and therefore the smaller ganglion-cells are also sensory, while the thicker fibres arising from the larger cells are motor.

The proboscis is provided with a well-marked nervous system, remarkable for the presence of unipolar ganglion-cells; this is regarded as a brain. If we ask how a brain is to be distinguished, we can merely answer, only by its relations to the sensory organs, and not by its constituent elements themselves. In the Nemertinea the nervous primitive organs have not exclusively concentrated themselves into an organic system of brain and lateral trunks, but are distributed over the whole body and its organs.

Eyeless Species of Oerstedtia.*—Dr. G. du Plessis calls attention to the fact that the *Oerstedtia* described by Claparède, the *O. pallida* of Keferstein, as well as a new species from Nice, which he calls *O. aurantiaca*, are all eyeless, and all have otocysts; while they agree in living in the damp soil near the edge of the water. It would be well, he thinks, to accept Dicsing's proposition to assign them to the genus *Typhlonemertes*.

Victorian Land Planarians.†—Prof. W. Baldwin Spencer has some notes on a collection of twelve species of Victorian Land Planarians, two of which are new; these he calls *Geoplana dendyi* and *G. frosti*.

He observes that, with regard to colour markings, the land Planarians as yet known in Victoria may be clearly divided into three main groups. The first has a uniform light tint all over the body, varying in different localities from white to orange, or a warm shade of grey. The second contains the dark coloured varieties, in which the upper surface of the body is blue, green, or brown; some of them have the ventral surface light, and others dark. In the third group are light-coloured varieties marked dorsally by dark stripes; some have a median and therefore odd number of stripes, and in others there is no median dark stripe.

Planaria alpina.‡—Herr A. Collin gives an account of a Planarian found at Sachsa in the Harz district, which appears to be the *P. alpina* described by Dana in 1766; the English *P. arethusa* of Dalyell is probably the same worm, as the Japanese *P. abscissa* of Ijima certainly is.

Notes on Entozoa.§—The late Prof. J. Leidy, in recording the presence of *Distoma crassum* in the Deer and Ox, suggests that there may be some relation between the occurrence of this parasite in the United States and the influx of a Chinese population. The facts coincide with the first discovery of *Trichina* in Man in England, and its subsequent discovery in the American hog. The Guinea-worm is believed to have been introduced into tropical America with the Negro from Africa. The larger variety of *Sclerostomum armatum* is reported from the lungs of a Horse, in which animal the parasite is generally found in the intestine. Some notes are given on the characters of *Ascaris anoura*.

* Zool. Anzeig., xiv. (1891) pp. 413-6.

† Proc. Roy. Soc. Victoria, iii. (1891) pp. 84-93 (2 pls.).

‡ S.B. Ges. Naturf. Freunde, 1891, pp. 177-80.

§ Proc. Acad. Philadelphia, 1891, pp. 234-6.

Parasites from Intestine of Zebra.*—Herr A. Collin reports that *Gastrophilus*, *Gastrodiscus*, and *Tænia* have been found in the intestine of a Zebra. Of the dipterous parasite 125 examples were present; the species is probably *G. equi*. *Gastrodiscus polymastos* was first found by Sonsino in Egyptian horses; the tape-worm is probably *T. Zebrae*, first mentioned by Sauber in 1779, and named by Rudolphi; it is very close to *T. perfoliata* of the Horse.

Parasites of Fishes.†—Sig. P. Sonsino describes a number of endoparasites in fishes:—In *Mugil cephalus*, *Microcotyle mugilis* Vogt, *Distomum viviparum* Van Beneden, *D. pachysomum* Eysenhardt, *Lecanoccephalus annulatus* Molin, and *Echinorhynchus agilis* Rud.; in *Tinca vulgaris*, *Triænoporus nodulosus* R. (larva), *Echinorhynchus angustatus* R., and *Monobothrium tuba* Dies.; in *Labrus mixtus*, *Distomum commune* Olsson, and *D. pulchellum* Rud.; in *Crenilabrus griseus*, *Distomum commune* Olsson, *Echinorhynchus Labri* R., and a larval *Agamonema* (sp. ?); in *Lophius piscatorius*, *Distomum macrocotyle* D., *D. cesticillus* Molin, *Gasterostomum gracilescens* R., and *Scolex polymorphus* R.; in *Trigla cuculus*, *Distomum rufoviride* R., *Trochopus tubiporus*, and *Echinorhynchus propinquus*; in *Box salpa*, *Monostomum orbiculare* R., *Distomum fractum* R., *Microcotyle salpæ* Par.; in *Umbrina cirrhosa*, *Distomum cesticillus* Molin, *Phylline Scienæ* van Beneden, *Diplectanum æquans* Dies, *Calceostoma inerme*, *Lecanoccephalus annulatus*, *Ascaris Scienæ* R. ?; in *Scienæ umbra*, *Phylline Scienæ*, *Calceostoma elegans* van Ben. and Hesse, and *Diplectanum Scienæ* Dies; in *Esox lucius*, *Triænoporus nodulosus* R., *Distomum tereticolle* R., and *Echinorhynchus angustatus* R.; in *Acipenser nasus*, *Amphilina foliacea* R.; in *Orthogoriscus mola*, *Distomum contortum* R., *D. nigroflavum* R., *Tristomum molæ* Blanch., and *T. papillosum* Dies. Sonsino found four tailed forms of *Distomum*. He also discusses the species of *Onchocotyle* and *Trochopus*.

Amphistomum chordale.‡—In making sections of the notochord of *Protopterus annectens* Herr R. Burchhardt found evidences of the presence of a Trematode; this is an organ in which these parasites have not yet been detected; owing to the thickness of the chordal sheath the parasites must enter when the fish is young. A short account of the worm is given.

New Species of Microcotyle.§—Sig. P. Sonsino describes from *Umbrina cirrhosa* a new species of *Microcotyle*, which he names *M. Pancerii*.

Species of Bothriocephalus.||—Herr F. Matz has studied numerous species of *Bothriocephalus*, especially with respect to their specific distinctions and their reproductive organs. The characters of *B. latus* cannot be attributed without modification to the other species. Matz describes *B. hians* Dies, *B. ditremus* Creplin, *B. dendriticus* Nitzsch, *B. punctatus* Rud., *B. claviceps* Rud., *B. infundibuliformis* Rud., *B. rugosus* Rud., *B. microcephalus* Rud., *B. fragilis* Rud., *B. plicatus* Rud.,

* SB. Ges. Naturf. Freunde, 1891, pp. 85-8.

† Atti Soc. Tosc. Sci. Nat., vii. (1891) pp. 253-65.

‡ SB. Ges. Naturf. Freunde, 1891, pp. 63-4.

§ Atti Soc. Tosc. Sci. Nat., vii. (1891) pp. 303-4.

|| Arch. f. Naturgesch., lviii. (1892) pp. 97-122 (1 pl.).

B. rectangulus Rud. He rejects a number of other species, and gives a key to the distinctive characters and distribution of those which he recognizes.

Length of Life of *Cœnurus*.*—Prof. A. Railliet had under his observation from 31st March, 1889, to 4th March, 1891, a Rabbit which was, when he got it, the host of a *Cœnurus* as large as a nut on its right leg. Before its death another as large as an apple appeared near its right shoulder. He concludes that *Cœnurus* may live as such for more than two years.

Experimental Development of *Cysticercus tenuicollis* in the Kid.†—Prof. A. Railliet fed a kid with *Tænia marginata* on the 20th June, and on the 29th the patient died. The liver was found to be gorged with blood, in which an enormous number of small vesicles were swimming; these were the embryos of the Tape-worm. Of the other organs of the body the lungs alone gave indications of the invasion of the parasite.

Presence of *Tænia nana* in America.‡—Dr. R. Blanchard reports the presence of *Tænia (Hymenolepis) nana* in an Argentine sailor who died at Buenos Ayres. Dr. Spooner appears to have observed the parasite in North America in 1872.

Migrations of *Tænia gracilis*.§—M. R. Blanchard has been able to work out the parasite found by Mr. T. Scott in the freshwater Ostracod *Candona rostrata*; it is the Cysticercoid stage of *Tænia gracilis*, which in the mature condition is found in Ducks. The young found by Linstow in the Perch, doubtless entered by mistake, being swallowed with their Crustacean hosts, but they would not mature in the fish.

δ. Incertæ Sedis.

Growth and Metamorphosis of *Tornaria*.||—Mr. T. H. Morgan believes that the similarities of *Tornaria* to the Echinoderm-larva are not to be explained by calling them superficial resemblances; they appear to have profound morphological significance. The details in common are very striking; thus the anterior enterocoel and its dorsal water-pore are identical in the two; some Auriculariæ have at least a pair of pores, and *Cephalodiscus*, which is undoubtedly allied to *Balanoglossus* (the adult form of *Tornaria*) has two such pores. The formation of muscles from the cells of the inner wall of the enterocoel is seen in both groups; in both there is an intimate connection between a part of the enterocoel and the so-called heart or anterior blood-vessel; in both a mesenchymatous vesicle is closely connected with the anterior enterocoel; wandering mesenchyme in the blastocoel is seen in both, and it is important to note that, also in both, there is an accumulation of many mesenchyme-cells around the endodermal œsophagus. The histology of the ciliated band is exactly the same in *Tornaria* and *Auricularia*, while the sudden and very great diminution in size of the larvæ at the time of metamorphosis is a very striking phenomenon.

* Bull. Soc. Zool. France, xvi. (1891) pp. 159-60. † Tom. cit., pp. 157-8.

‡ Tom. cit., pp. 165-7.

§ Tom. cit., pp. 119-22 (1 fig.).

|| Journ. Morphology, v. (1891) pp. 407-58 (5 pls.).

There are, of course, differences between them; the apical plates and eyes seem to be absent in *Auricularia*, and in it the muscle-band from the apical plate (in *Tornaria*) is not represented. The great difficulty in the comparison is the presence of two posterior pairs of enterocoels in *Tornaria*, but it is to be remembered that there are still unsolved problems of metamerism. The large posterior circular band of *Tornaria* seems to be a structure *sui generis*.

However, the point most to be, though not generally, emphasized is that it is the young *Tornaria* and not the older larva that most closely resembles the Echinoderm-larva. The identity cannot be explained as being due to similar conditions of life in the two forms, for the most essential points of comparison relate to the internal organs.

Mr. Morgan is of opinion that *Balanoglossus* has affinities not only to Echinoderms but also to the Chordata; if this be so it is clear that the Vertebrate-phylum is a very old one, and one which it is futile to attempt to derive from such specialized animals as the Annelids of to-day.

Development of Sagitta.*—M. S. Jourdain does not accept the account of the formation of the archenteron of *Sagitta* given by Kowalevsky and Bütschli. The archenteron does not, he asserts, give rise to the coelom. He considers that what happens is this: a depression appears at the oral pole of the egg, and is lined by epiblast. As the depression becomes more and more marked it drives before it the hypoblast, which in time breaks through. In this way a communication is effected between the hypoblastic cavity and the exterior. The three archenteric lobes all belong to the digestive tract, and the lateral lobes gradually disappear. As this last event is occurring, there is a process of delamination between the epiblast and hypoblast, and a mesoblastic cavity is thereby formed which, later on, becomes the coelom of *Sagitta*. With the growth of the embryo this becomes, posteriorly, a spacious cavity. On the sides of the hinder part of the intestine there appear early cellular growths which give rise to the male and female organs. These do not arise in but outside of the archenteron. Although the author has not been able to study in sufficient detail the development of the nervous system, he suspects that the type is not as far removed from the Vertebrate as is generally supposed; and he thinks that *Sagitta*, *Amphioxus*, and the Ascidians form a special group which he calls "Préverfébrés."

Notops minor.†—Mr. C. Rousselet describes this new rotifer which he found on several occasions in Epping Forest; it has a general resemblance to *N. hyptopus*, but is only about a quarter of its size; it has also a flask-shaped appearance, and is more compressed laterally. The absence of a sperm-sac shows that it is not the male of the allied species, as the author first thought might be the case.

Two New Rotifers.‡—Mr. C. Rousselet also describes *Conochilus unicornis* and *Euchlanis parva*, both from Keston; the former has the ventral antennæ joined together within a single sheath on the surface of the corona; the latter is much smaller than its congeners, has the toes

* Comptes Rendus, cxiv. (1892) pp. 28-9.

† Journ. Quek. Micr. Club, iv. (1892) pp. 359-60 (2 figs.).

‡ Tom. cit., pp. 367-70 (6 figs.).

rather more than one-third the size of the body; the lorica is egg-shaped, and the ventral plate is small and flat.

Sense of Vision in Rotifers.*—Mr. C. Rousselet describes the way in which *Pedalion* escapes from a pipette, and suggests that it can see close objects, and is not merely affected by light and shade. It is probable that many other Rotifers can perceive a distinct image, especially those whose eyes are exactly similar in structure to those of *Pedalion*.

Two Male Rotifers hitherto undescribed.†—Mr. G. Western found the male of *Notops clavulatus* in a gathering from Richmond Park; the average length was 1/140 in. and the general contour is that of the female; the male of *Triphylus lacustris*, which is a reproduction in miniature of the form of the female, was found at Chingford; the average length was 1/83 in.; the females taken on the same occasion were much larger than usual.

Two Rotifers from Epping Forest.‡—Mr. F. A. Parsons describes two forms which appear to be new. *Callidina magna-calcarata*, and *Pterodina cæca*; both live commensally on *Asellus*. The former is most conspicuous by the presence of two large spurs, and is most like *C. socialis*; the latter is minute and elegant, and, as its specific name implies, appears to be without eyes.

Salinella—a new Mesozoon.§—Dr. J. Frenzel describes *Salinella salve* g. et sp. n., a remarkable Infusorian-like multicellular organism which he found in salt solutions at Cordoba in Argentina. The normal length of the animal is .18-.22 mm.; it is sac-like in shape, like many Turbellarians; both ends are rounded off; there is a dorso-ventral flattening. The organism is multicellular, but has only a single layer of cells. The ventral surface is finely ciliated; the back and sides bear short bristles. The mouth lies anteriorly, subterminally and ventrally, and bears strong cirri; the anus is terminal and bears stiff bristles. The internal cavity is lined by long cilia. Reproduction occurs by transverse division, and there is also encystation preceded by conjugation. The young larval form is unicellular.

As to the life of this strange organism, it occurred in an aquarium in which salt from native brine deposits was dissolved; it fed on debris caught up by the oral cirri; digestion and absorption, aided perhaps by numerous bacteria, occurred within its cavity. The movements were somewhat worm-like and referable to the contractility retained by all the cells. During growth, the cells divide in an amitotic fashion, but not by "direct" nuclear division. The unicellular larva feeds like a Protozoon, and its first divisions are almost, if not quite, mitotic.

Echinodermata.

Ludwig's Echinodermata.||—Prof. H. Ludwig has completed the first volume of his work on Echinoderms, and now brings to an end

* Journ. Quek. Micr. Club, iv. (1892) pp. 371-3 and 376-7.

† Tom. cit., pp. 374-5 (8 figs.).

‡ Tom. cit., 378-80 (5 figs.).

§ Archiv f. Naturgesch., lviii. (1892) pp. 66-96 (1 pl. and 4 figs.).

|| Bronn's 'Klassen u. Ordnungen,' II. 3. Echinodermen, parts 15 and 16, pp. 377-460 and vi.

his account of the Holothurians. After finishing the subject of geographical distribution, which he began in a previous part, and telling us that the greatest depth from which Holothurians have been taken is 2900 fathoms, he passes to physiology and œcology; the functions of the several organs and systems are first dealt with, and afterwards, among others, locomotion, nutrition, reaction to strong stimuli, regeneration, length of life and rapidity of growth, enemies, protective arrangements and parasites are discussed in detail.

The young are sometimes cared for by the parent, and in three different ways; the cœlom serves as a brood-cavity in *Phyllophorus urna*, *Synapta vivipara*, and *Chiridota rotifera*; the eggs and young are attached to the back of the mother in *Cucumaria crocea*, and *Psolus ephippifer*; the eggs are placed in special brood-pouches, formed by invagination of the skin in *Cucumaria lævigata* and *C. minuta*. The only Holothurian that is known to swim is *Stichopus natans*, which Sars observed moving like a Planarian or a Lecch.

After detailing the uses of Holothurians to man, and the little that is known concerning their palæontology, the author concludes with a discussion of their phylogeny; the tree now given does not differ from that which we have already reproduced.* He concludes that, on the whole, the existing Aspidochirotae and Dendrochirotae represent the typical Holothurians; though they have, it is true, diverged from the primitive form, they have remained more like it than the Elasipoda, Molpadiidæ, and Synaptidæ; these last are a very old group, but at the same time the one that is most divergent from the primitive form. The author criticizes the views of those who have held different views from these as to the interrelations of the groups of Holothurians.

Physiology of Nervous System of Echinoderms.†—Drs. J. Demoor and M. Chapeaux have made a number of experiments on *Asterias rubens*. With regard to the general anatomy of the nervous system it may be said that, while it is diffuse in character, a tendency to centralization is shown in the condensation of ganglionic elements at definite points. With regard to their functions the authors' experiments lead them to conclude that the co-ordinated movements which cause the turning of a starfish laid on its back are reflex actions dependent on the condensed nervous system; the intervention of the circumoral centres increases the rapidity with which this action is performed. The authors have studied the curious property of self-mutilation or autotomy possessed by some Starfishes, and conclude that, so far as the motor reaction is concerned, autotomy is a reflex action, the centre of which is placed in the nerve-ganglion of the arm. The intensity of the phenomenon is a function of the number of ganglia which act in concert.

The tentacles exhibit movements of extension and of retraction; the latter is the result of a simple reflex action, the irradiation of which in the condensed nervous system is proportionately more rapid as it occurs closer to the circumoral cord; the influence of the periesophageal centres is manifested in this phenomenon. Extension is a reflex

* This Journal, 1891, p. 478.

† Tijdschr. Nederl. Dierk. Vereen., iii. (1891) pp. 108-69 (1 pl.).

of the second order consequent on an irritation diffusing itself strongly in the condensed nervous system. This irritation is caused by the strong stimulation of any point of that system which produces retraction, or by the stimulation of the diffused system which is transmitted to the ventral nervous system. The phenomena of extension of the tentacles does not necessarily depend on the ganglia, although the ganglionic influence has a marked action on the propagation of this reflex action, which is always centrifugal. The reacting power of a normal *Asterias* depends on the functional integrity of the diffused system, for it gives the power of reaction to the condensed system, and it is the first cause of that automotor power, which is the principal function of the condensed nervous system.

The diffused nervous system is the seat of perception and sensation, and keeps the animal in a state of activity, but it must not be forgotten that the relations between it and the condensed system are exceedingly close.

The results of experiments with a number of poisons and with heat are given in the final part of the memoir.

Notes on Echinoderm Histology.*—Mr. H. E. Durham, on the present occasion, confines his remarks to structures on which his observations do not tally with those of other histologists. He first gives an account of the "dorsal organ" of Starfishes; examined with a low power in the living state it has a lobulated appearance, and is seen to consist of a number of strands of tissue upon which may be transparent swellings of various sizes. Under a high power longitudinal fibrils may be detected as well as large numbers of cells similar to the leucocytes seen in the cœlomic fluid; there are but few cilia on the surface of the organ. The functions of the hemal system appear to be (1) The distribution in a state of solution to the various organs of nutrient substances absorbed from the gut; (2) The distribution of nutrient substances by means of amœboid cells which use the strands of the system, as it were, like railway lines; (3) It is the site for the production of amœboid corpuscles; (4) It has some concern with the working up of effete material.

Suggested Terms in Crinoid Morphology.†—We can only call attention to a number of new terms suggested for the use of the student of Crinoids which Mr. F. A. Bather has proposed; the chief objects in view have been to give the same name to homologous parts, and to insure that parts which are serially homologous should receive names of a similar nature.

Cœlenterata.

Morphology of Actinozoa.‡—In the present memoir Prof. J. Playfair M'Murich deals with the development of the Hexactiniae. He commences with an account of the segmentation of the egg and formation of the germ-layers in *Metridium*; he finds that in all known cases the endoderm of the Actinozoa is formed by delamination, but this result only leads to the further question—was delamination the primitive

* Quart. Journ. Micr. Sci., xxxiii. (1891) pp. 104-16.

† Ann. and Mag. Nat. Hist., ix. (1892) pp. 51-66.

‡ Journ. of Morphology, iv. (1891) pp. 303-30 (1 pl.).

method or is it a secondary modification of a still earlier phenomenon. The author believes that the Hexactiniae are descended from forms whose ova possessed a relatively large amount of food-yolk. The original condition is found in the Aleyonaria, and the more typical delamination of the Hexactiniae has been derived from this. In *Renilla* the central cells, heavily laden with food-yolk, are separated from the proportionately more protoplasmic ectoderm; later, a certain number of the cells become transformed into the endoderm layer, while the rest degenerate, and their contents serve as food for the developing embryo. This, though to a less extent, is seen in *Manicina*. In *Metridium* the yolk is much more reduced, so that the blastula cavity never becomes filled up; the delaminated cells are almost all converted into the definite endoderm, a few only disintegrating and giving rise to the granules of food-yolk which lie in the endodermal cavity.

The next subject discussed is the formation of the first eight mesenteries in *Rhodactis*. So far as can be judged it would appear that in *Rhodactis* there is no reflection of the stomodæal ectoderm in connection with the formation of the mesenterial filaments, and in *Aulactinia* the evidence points in the same direction. The essay concludes with an account of some later stages in *Aulactinia*. They lead to the conclusion that the median streak was the first to make its appearance in the ancestors of the Actinozoa, who remained for some time with simple glandular filaments, formed by a differentiation of the endodermal cells along the free edges of the mesentery. Later on, the ciliated respiratory portions of the mesentery developed by a down-growth of the stomodæal ectoderm; they were first confined to the upper portion of the mesentery, where the glandular streak was not developed, but, later, they extended their limits, came to overlap the glandular portion, and gave a trilobed form to a portion of the filament.

Revision of British Actiniae.*—In the second part of his revision, in which Prof. A. C. Haddon has had the assistance of Miss A. M. Shackleton, the Zoantheæ are dealt with. This is a group in which it is above all things necessary to combine anatomical and microscopical examination with the methods of the older zoologists, for the species of Zoantheæ can only be established after sections have been cut and studied. The authors point out that the identification of new material with recognized species requires the utmost circumspection. A useful account is given of the general anatomy of the group; of the mesogloea it is noted that its ground substance is always homogeneous; it is perforated by numerous minute cells which are sometimes star-shaped, but more often produced at each end into a long fibril which extends in a radial direction. Some of the fibrils are undoubtedly connected with the ectoderm, and others with the endoderm. The base of the endoderm forms a feeble but complete muscular sheath; this becomes converted in the capitular region into a sphincter muscle, which in contraction causes the introversion of the corona and capitulum.

It is proposed to divide the Zoanthidæ into two, new, subfamilies to be called Brachyneminiæ and Macroneminiæ; the former have the sulcar element of the primitive sulco-lateral pairs of mesenteries (cnemes)

* Scient. Trans. R. Dublin Soc., iv. (1891) pp. 609-72 (2 pls.).

imperfect, and the latter have it perfect; the genera placed in the former are *Zoanthus*, *Isaurus*? *Mammillifera*, *Gemmaria*, *Polythoa*, and *Sphenopus*; in the latter are *Epizoanthus* and *Parazoanthus* g. n. (for *P. axinellæ* Schmidt). Very careful descriptive and synonymic accounts are given of the British species, for which the authors should have the gratitude of all who are interested in one of the most intricate and difficult of groups of Animals.

Zoantheæ of Torres Straits.*—Simultaneously with the above the same authors have given an account of the Zoantheæ collected by Prof. Haddon in Torres Straits in 1888 and 1889. Of the twelve species described all but two were unknown to science.

Gastrulation of *Aurelia flavidula*.†—Mr. F. Smith, after giving details of his observations on the earliest developmental stages of *Aurelia flavidula*, enumerates the variations in gastrulation exhibited by the Scyphomedusæ. The solid planula of *Cyanea arctica* is said to be formed by the immigration of certain of the blastula-cells; this planula is subsequently hollowed out, and gives rise to a structure like an invaginate gastrula, but there is no invagination. In *C. capillata* there seems to be a solid ingrowth of cells from one pole of the embryo, and a simultaneous development of the cœlenteron; in *Chrysaora* the endoderm is similarly developed. The gastrulation of *Aurelia aurita*, according to Claus, is rather more like the method by invagination than that of *Chrysaora*, since its cells are arranged in a single layer about the fissure-like cœlenteron; in *A. flavidula* the invagination is still more typical, since the cœlenteron is from the beginning an open sac-like cavity. In *Pelagia noctiluca* and *Nausithoe marginata* there is, as Metschnikoff has shown, a typical invagination. If any mode is typical it is that by invagination and not that by ingression.

Porifera.

Development of Sponges.‡—Mr. H. V. Wilson has notes on the gemmule-development of *Esperella fibrezilis* and *Tedania Brucei* spp. n., as well as a few observations on the egg-development of *Tedanione fatida* g. n. and *Hircinia acuta*.

The mesoderm of *Esperella* contains cells which differ greatly in size and general appearance, though the varieties shade into one another. Some, much larger than the rest, have plump bodies which stain well. These congregate together and form irregular groups; the group rounds itself off, the outer cells becoming flattened and forming a follicle. Thus a gemmule is formed; it increases in size by means of cell-growth and division, and by the fusion of neighbouring small gemmules. When nearly as large as the swimming larva it may be spoken of as the ripe gemmule. It next undergoes a process which has a superficial resemblance to segmentation, for it splits up into irregular masses of cells. The outer cells very early arrange themselves so as to form a continuous layer of flat cells round the periphery; within is a mass of amœboid cells

* Scient. Trans. R. Dublin Soc., iv. (1891) pp. 673-701 (4 pls.).

† Bull. Mus. Comp. Zool., xxii. (1891) pp. 115-25 (2 pls.).

‡ Journ. of Morphology, v. (1891) pp. 511-9.

connected by their processes and separated by fluid. Cilia and pigment next appeared on the outer cells, except at one pole.

After describing the metamorphosis the author points out that the history of development favours Metschnikoff's theory that the ancestors of Sponges were solid. Attention is drawn to the striking resemblance between this asexual development and the egg-development of many siliceous Sponges. This resemblance can, the author thinks, only be explained on the supposition that there is some essential likeness between the mesoderm-cells which make up the gemmule and ova. He is inclined to regard the gemmule cell as a true germ-cell in which all the germ-plasm remains undifferentiated, or, in other words, is not transformed into oogenetic plasm. Moreover, the gemmule-cell preserves the parthenogenetic course of development—it keeps all its germ-plasm. As gemmules apparently develop anywhere in the Sponge-mesenchyme it must be supposed that any mesenchyme-cell may become a gemmule-cell, and consequently that it contains germ-plasm. We are led to the same conclusion by the study of egg-development, for it seems that any mesenchyme-cell may develop into an egg.

The gemmule development in *Tedania* is of much the same character as in *Esperella*. *Tedania* and *Hircinia* have both solid morulae.

Histology of Leucosolenia.*—Mr. E. A. Minchin gives an account of a sieve-like membrane which he has observed across the oscula of a species of *Leucosolenia*, together with some observations on the histology of that Sponge. This membrane is composed of two layers of cells in apposition, but separated by a thin layer of jelly; the cells are continued out from their central portion into three, four, five, or even six processes, which, uniting with the processes of other cells, form a network with comparatively wide meshes. The best preparations are obtained by fixing with osmic acid, which preserves the shape of the network, and staining with picrocarmine, which removes the blackening to a great extent. The inner of the two layers of the membrane becomes directly continuous with the layer of collared epithelium which composes the endoderm of the sponge. The outer layer is similarly continuous with the ectoderm. It is probable that the inner layer is of endodermal, and the outer of ectodermal origin. The function of this membrane appears to be that of keeping intruding animals out of the gastric cavity.

The collar-cells of the endoderm were observed to vary in shape, and to have no trace of a collar, which, therefore, must be supposed to be retractile. The flagellum is twice as high as the cell or higher; it makes a somewhat slow stroke to the right, followed immediately by a quick stroke to the left; after a pause these motions are repeated. The contact of a foreign body stimulates a flagellum to greater activity. The process is really cylindrical, and the apparent tapering to a point is an optical delusion.

No trace of muscular, elastic or other special cells was found in the mesoderm. The superficial ectoderm cells were very difficult to make out, and the author suggests that, in the fully-formed sponge, the ectoderm-cells may, to a certain extent, degenerate into a cuticle-like structure. No trace in either living or preserved specimens could be detected of

* Quart. Journ. Micr. Sci., xxxiii. (1892) pp. 251-72 (2 pls.).

flagella, which are described by von Lendenfeld as present in all Calcareous Sponges, and the author expresses scepticism as to their existence.

Sponges of Oceanic Shores of France.*—M. E. Topsent gives a list of forty-one species of Sponges collected on the coasts of France that are washed by the Atlantic; of these all but three have already been found also on the northern coasts, but a closer study of the fauna of the Bay of Biscay would probably reveal some new forms.

Protozoa.

Remarkable Argentine Protozoa.† — Prof. J. Frenzel describes several remarkable Protozoa which he has observed in the Argentine Republic. *Chromatella argentina* g. et sp. n. is an Amœboid organism with a diameter of only .005 to .006 mm. Its form is like that of *Amœba* (*Dactylosphæra*) *radiosa*, the pseudopodia move slowly, and serve also as tactile and seizing organs. As they radiate in all directions no anterior or posterior end is indicated. There is but slight differentiation into ectoplasm and endoplasm; the protoplasm contains a number of small granules. In the living state no signs of a nucleus are discernible; there is only one pulsating vacuole. After trying a number of reagents the author was forced to conclude that the nuclear substance was represented merely by granules.

Giringa filiformis g. et sp. n. has a certain resemblance to *Biomyxa vagans*; it is small in size, of an elongated spindle shape, each pole gradually passing into a pseudopodium which is generally curved like an S. The contour of the body is knobby rather than smooth. There is no distinction into ectoplasm and endoplasm, and what are called pseudopodia are nothing more than thinned out continuations of the body. There are three to five vacuoles, which pulsate at regular intervals. Nothing can be certainly said as to the presence of a nucleus.

Giringa (*Protamœba*) *flava* sp. n. is in optic section multangular, and the pseudopodia are given off as delicate and almost filamentary processes from the angles. They are curved and branching, but they do not fuse to form a network. The contour is still rougher than in *G. filiformis*. No signs of a nucleus could be detected.

Stylamœba sessilis g. et sp. n. is interesting as being the first true Rhizopod which is known to lead a fixed life. The central body is spherical to oval and has two poles; from the lower pole there is given off the foot, in the form of a pseudopodium, while two or three pseudopodia radiate from the upper pole; the footstalk passes more or less gradually into the body, so that the whole has the form of a *Vorticella*; the upper pseudopodia are thin and finger-like, and have rounded ends. The foot is capable of considerable contraction, or may thin out to a filament; the pseudopodia move like the tentacles of a *Hydra*. The endoplasm is distinct from the ectoplasm, and not only occupies the centre of the body, but also the whole of the foot; it is very rich in granules. A nucleus is present, but reagents are needed to make it distinctly visible.

* Bull. Soc. Zool. France, xvi. (1891) pp. 127-9.

† Zeitschr. f. Wiss. Zool., liii. (1891) pp. 331-60 (1 p^l).

Saltonella saltans g. et sp. n. forms a very simple geometrical figure, and, in optical section, is semicircular, triangular, quadrangular or pentagonal. It neither forms pseudopodia in the ordinary sense or exhibits the sac-like flowing movement of some Amœbæ. *Saltonella* ordinarily lies still, but of a sudden a piece springs forwards as much as the diameter of the body, and then there is a pause of uncertain duration. The author was unable to assure himself of the mechanism of this hopping movement, but thinks it may be due to a momentary powerful contraction. There is no differentiation into ectoplasm and endoplasm. It is not impossible that this organism is only a developmental stage of some other form.

Eickenia rotunda g. et sp. n. has much resemblance to the Phycomyces, and is, perhaps, not a Rhizopod at all. No true pseudopodia were observed. It has a distinct membrane-like tegumentary layer, which is colourless and transparent. It moves slowly, but may have another stage in which it is more active.

The only Heliozoon now described by the author is *Mastigophrys radians* g. et sp. n., which was found in an infusion of plants. It has a pretty thick investing layer, in which there are no isolated skeletal parts. A single Choanoflagellate is also briefly described, which Dr. Frenzel calls *Diplosiga socialis* g. et sp. n.; in its general appearance it resembles *Codonodesmus* or *Desmerella*. *Suctorella ciliata* g. et sp. n. is a Suctorian which is briefly described, and, in conclusion, there are observations on two new forms of Protozoa, whose systematic position is obscure; one is named *Peitiada mirabilis* and the other *Microhydrella tentaculata*.

Zoochlorellæ.*—Herr A. Famintzin concludes that the zoochlorellæ are symbiotic forms of the *Protococcus*-like *Chlorella vulgaris* which Beyerinck and he discovered living freely. The free-living Alga and the isolated zoochlorellæ of *Paramæcium bursaria*, *Stylonichia*, and *Stentor* can live and divide in solutions of inorganic salts. The symbiosis is complex; the Algæ decompose carbonic acid in the light and afford abundant oxygen to the surrounding plasma; in the light they flourish well within the animals, but in darkness and sometimes in other (unanalysed) conditions they are more or less digested or expelled; they certainly may be used as food by the Infusorians in which they live. Three species, "readily distinguishable by their dimensions," are known:—*Zoochlorella parasitica* (1.5–3 μ in diameter); *Z. conductrix* (3–6 μ), and *Z. maxima* (12 μ).

Elsewhere† Herr Famintzin explains why he did not in his history of the subject take account of Schewiakoff's observations on infecting *Frontonia leucas* with zoochlorellæ; he regards these observations as inconclusive. The manner in which the symbiotic union is effected remains obscure.

Trichosphærium Sieboldii.‡—Prof. R. Greeff notices that he described in 1869 this remarkable Rhizopod which Schneider named in 1878. He corroborates some of his original observations, that the

* Mém. Acad. Imp. St. Pétersbourg, xxxviii. (1891) No. 4, pp. 1–16 (1 pl.).

† Biol. Centralbl., xii. (1892) pp. 51–4.

‡ Zool. Anzeig., xv. (1891) pp. 60–64.

covering of "bristles" consists of needles of carbonate of lime, and that the pseudopodia are remarkable in being long and rod-like. Of a definite nucleus he finds no trace. As to the systematic position of *Trichosphærium*, Greeff places it among the monothalamous Foraminifera, although the relatively large openings of the shell and the long, rod-like, unbranched pseudopodia are certainly divergent. Perhaps *Orbulinella smaragdea* and the organism which Alexander Stuart described in 1866 as *Coscinosphæra ciliata*, are allied forms.

Gregarines of Tunicates and Capitella.*—Dr. P. Mingazzini defines a new genus *Lankesteria* including *Monocystis Ascidiæ*, described by Prof. Ray Lankester; a new genus *Leurozyga* (with lateral conjugation) including *P. Distapliæ* sp. n. in *Distaplia*, and *P. Bütschlii* sp. n. in *Phallusia*; a new genus *Anchorina* (of anchor-like form) from *Capitella*.

Gregarines of Holothurians.†—Dr. P. Mingazzini establishes a new genus *Cystobia* for *Gregarina holoturix* which Anton Schneider found in *Holoturia* (*Holothuria* ?), *tubulosa*, and for *Cystobia Schneideri* sp. n. which Mingazzini found in *H. Poli* and *H. impatiens*.

* Atti R. Accad. Lincei (Rend), vii. (1891) pp. 407-14.

† Tom. cit., pp. 313-19.



BOTANY.

A. GENERAL, including the Anatomy and Physiology
of the Phanerogamia.

a. Anatomy.

(1) Cell-structure and Protoplasm.

Elementary Structure and Growth of Living Substance.*—In this very important work, Prof. J. Wiesner further explains his views on the structure and growth of the living cell and of the substances of which it is composed.

All the properties of living structures can only be derived from similar properties in previously existing living structures, and must have been propagated by division; and on this process of division depends also ultimately even sexual reproduction. That vegetative reproduction depends entirely on the specialized capacity of certain cells for division is shown by the propagation of *Begonia* from fragments of leaves. Any meristem-cell which gives birth to a new individual may be compared to an impregnated ovum-cell, and is termed by Wiesner a "secondary embryonic cell." The difference between propagative cells which can originate new individuals in a non-sexual way and ordinary vegetative cells, is that the former contain far more germ-plasm. The transformation of resting-cells into meristem-cells, i. e. into propagative cells, is effected by the passage into them of plastic substances out of neighbouring cells. In both animals and plants the formation of organs depends entirely on cell-division; all visible new-formations of the living organism are produced by division. But this capacity for division of the living substance is not unlimited; it does not go so far as the breaking up into molecules.

The composition of living substance out of minute plasomes holds good not only for such bodies as pyrenoids and starch-grains, but also for protoplasm and the cell-wall; and these plasomes the author states to be directly visible. The cell-wall of living cells consists by no means exclusively of cellulose, though cellulose is one of its most important ingredients; it very often contains protoplasm. That the cell-wall is not entirely passive in the vital phenomena of the plant is shown by a great variety of circumstances. Dr. Wiesner does not, however, agree with previous writers as to the physical structure of the cell-wall. He states that it is composed of fine fibrillæ, and these again of very delicate roundish particles, the dermatosomes; the best mode of demonstrating these is by subjecting the cell-wall to the influence of chlorine water for weeks.

The structure of the protoplasm is not the same in all cells. In many cases it forms a network; in others it is composed of interwoven threads; while in others again it has a honeycomb-like structure; and the structure may vary in one and the same cell. In hyaline and homogeneous protoplasm the plasomes are probably not closely crowded, as they are in the cells of a meristematic tissue. The nucleus is, like

* 'Die Elementarstruktur u. d. Wachstum d. leb. Substanz,' Wien, 1892, 283 pp. See Biol. Centralbl., xi. (1891) p. 705. Cf. this Journal, 1891, p. 207.

the protoplasm, also composed of plasomes. In fact, all organized parts of the cell resemble one another in being composed of plasomes, out of which stationary partielles, such as dermatosomes, protoplasm-granules, &c., are composed.

The growth of living substance takes place either by intussusception or by apposition. Intussusception may be either cellular or molecular, the latter corresponding to Nägeli's use of the term. Cellular apposition may take place in three modes, viz. (1) by the deposition of similar cell-partielles, (2) by the deposition of dissimilar cell-partielles, (3) by the apposition of cells, which is almost always combined with cellular intussusception. Differentiation is that process which completes itself in the growth of certain parts of plants, by which special portions of the living substance, which appear at first homogeneous, undergo a change, while the rest remain unchanged.

The mode in which turgor acts in causing growth has not been correctly understood by previous writers. It acts not merely as a mechanical pressure which stretches the cell-wall, but also as an irritation on those structures—the plasomes—on the growth and division of which the growth of the cell-wall, and therefore also that of the cell, depends by bringing about their division.

With regard to the relationship between the cell-protoplasm and the cell-nucleus, it has been shown that a differentiated nucleus is not an absolutely necessary constituent of the cell; there are cases, e. g. *Saccharomyces* and *Nostocaceæ*, in which the nuclear substance is distributed through the protoplasm. Wiesner regards the protoplasm and the nucleus as phylogenetically of the same age. The homogeneous cell-body of the simplest organisms forms an undifferentiated plasm, the *archiplasm*; from this both nucleus and protoplasm have been differentiated in the course of phylogenetic development.

Presence of Pectic Substances in Tissues.*—M. L. Mangin gives an exhaustive and critical account of what has been written respecting the pectic substances found in vegetable tissues, and their relationship to the "intercellular substance" of Mohl, described by later writers as the "primary membrane," "median lamella," and "outer lamella." His principal object is to demonstrate the autonomy of this group of substances, and to justify their introduction among the fundamental substances of the cell-wall of the same rank as cellulose.

The following are the chief chemical and physical reactions of this group of substances. They are soluble in Schultze's reagent, and in caustic alkalies, but insoluble in sulphuric acid; they are always optically isotropous; they rarely give the reactions of cellulose, but sometimes manifest the properties of lignin. It is these substances which are dissolved in the processes of fermentation and putrefaction; and it is they that form the "protoplasmic" lining of intercellular spaces. Wherever the production of pectic or of other allied substances takes place, it is connected with the process of gelification.

* Journ. de Bot. (Morot), v. (1891) pp. 400-13, 440-8; vi. (1892) pp. 12-9. Cf. this Journal, 1890, p. 475.

(2) Other Cell-contents (including Secretions).

Plastids.*—According to M. R. Chodat, all trophoplasts (chloroplasts, chromoplasts, and leucoplasts) have nearly the same structure, consisting of a colourless stroma, permeated by irregular lacunæ; while slenderer prolongations or transverse links of the stroma project into the lacunæ, and subdivide them. The plastids have no special membrane; the outermost layer is the continuous substance of the stroma itself. When a chromoplast is transformed into a chloroplast, it is not its structure that undergoes a change, but only the pigment. This covers the inner wall of the lacuna without filling it up, and the dark colour of the coating is simply the result of shadow. Schimper's "crystalloids" have the same spongy structure as the plastids. Specially good subjects for observation are furnished by the chlorophyll-grains in the pseudo-bulb of *Calanthe Sieboldi*, and the chromoplasts in the mesocarp of the fruit of *Capsicum chilense*.

Aggregations of Proteid in Euphorbia.†—Mr. R. E. Fry describes some remarkable spherical aggregations in some of the cells of the stem of *Euphorbia splendens*, especially in the parenchyme immediately surrounding the vascular bundles; the micro-chemical reactions showed these bodies to consist of coagulated masses of proteid. In the fresh state the proteid occurs in various forms,—either distributed throughout the cell-contents as a fluid, or in finely divided granules, or in various crystalloid forms. The distribution of these bodies in the stem, viz. in the inner layers of the cortex just outside the bast, in the medullary rays, and in the pith just within the wood, as well as experiments on growing plants, indicate that the proteid is used as reserve nitrogenous material, corresponding to starch among the carbohydrates. Similar bodies were observed in *Euphorbia Bojeri*, but not in any other latex-containing plant belonging either to the Euphorbiaceæ or to any other natural order.

Raphides in the Embryo.‡—Dr. H. Micheels records the presence of raphides of calcium oxalate in the embryo of two species of palm, *Ptychosperma Alexandræ* and a *Caryota*.

Formation of Crystalloids in branches of the Potato.§—Investigating the nature of a disease which has caused great destruction of the potato crop in parts of Tyrol, Herr E. Heinricher found that it is accompanied by an enormous accumulation of proteid crystalloids in the lower part of the stem. This appeared to be the result of the very wet season, which had caused rotting of the roots and consequent failure to produce tubers. The proteinaceous food-material which should have been employed in the formation of the tubers remained stored up in the leafy shoots. Their principal seat was the cortical parenchyme and the phloem of the vascular bundles.

Diastase in Pollen.||—Prof. J. R. Green records the occurrence of diastase in the pollen-grains of *Helianthus*, *Lilium*, *Gladiolus*, *Anemone*,

* Arch. Sci. Phys. et Nat., xxv. (1891) pp. 244-8 (1 pl.).

† Ann. of Bot., v. (1891) pp. 413-8 (1 pl.).

‡ Bull. Acad. Roy. Sci. Belgique, xxii. (1891) pp. 391-2.

§ Bcr. Deutsch. Bot. Gesell., ix. (1891) pp. 287-91 (2 figs.).

|| Ann. of Bot., v. (1891) pp. 511-2.

Antirrhinum, and *Pelargonium*. It is quite independent of the protoplasm, and can be extracted by treatment with dilute glycerin. This presence of diastase may be of great physiological importance in connection with the power of the pollen-tube to avail itself of the nutriment obtained from the tissue of the style, as germination proceeds through its later stages.

Oil-decomposing Ferment in Plants.*—Pursuing his investigations on this subject, Dr. W. Sigmund finds a considerably larger proportion of fatty acid in germinating seeds than in seeds in the dormant condition; and this seems to be especially the case when they germinate at high temperatures. The observations were made on the seeds of the turnip, hemp, poppy, flax, &c.

Chemical Composition of Leguminous Seeds.†—Herren E. Schultze, E. Steiger, and W. Maxwell give a detailed account of the composition of lupin seeds and of the methods employed in estimation of the various constituents. Analyses of the seeds of *Vicia sativa*, *Pisum sativum*, and *Faba vulgaris* are also given, and the seeds of *Soja hispida* are mentioned as being somewhat remarkable in that they contain more cane sugar than the others. They also contain 1.64 per cent. of lecithin.

(3) Structure of Tissues.

Laticiferous tubes of Euphorbiaceæ, Urticaceæ, Apocynaceæ, and Asclepiadeæ.‡—M. L. G. Chauvcaud has carefully examined the origin of the laticiferous tubes in these three natural orders.

In the Euphorbiaceæ (the researches having been chiefly confined to the genus *Euphorbia*) the mode of the first development of the laticiferous apparatus is not uniform, the difference depending mainly on the number of initial cells present in the embryo. As a general rule these initial cells are numerous, and form, in the first place, a complete layer surrounding a central cylinder, the exact structure of which is uniform in each species. In some species the number of these initials is reduced to eight, or even to four. The generating layer of these initials is always situated in the "nodal plane," which coincides with the base of insertion of the cotyledons. No anastomosing could be detected, either of the laticiferous tubes among one another, or between these tubes and the adjacent tissues.

In the Asclepiadeæ and Apocynaceæ we find a somewhat different type; in some of these the embryo has no cortical prolongation in its tegillum. In the Asclepiadeæ the central tubes are generally inflected in the region of the collar; they leave the central cylinder and penetrate the cortex, in the interior of which they continue their growth.

In the Urticaceæ the initials of the laticiferous tubes are arranged in groups of five in the face of the two notches in the cotyledons.

In its development, during germination and subsequently, the laticiferous apparatus preserves essentially the same arrangement that it presents in the embryo as far as the stem and its branches are con-

* SB. K. Akad. Wiss. Wien, c. (1891) pp. 328-35. Cf. this Journal, 1891, p. 221.

† Landw. Versuchs-Stat., xxxix. pp. 269-326. See Journ. Chem. Soc., 1891, Abstracts, p. 1541.

‡ Ann. Sci. Nat. (Bot.), xiv. (1891) pp. 1-161 (8 pls. and 3 figs.).

cerned, though this is not true to the same extent of the root. No fresh initials are formed after the first stages of development within the embryo. The terminations of the tubes are not localized in a special tissue; but may occur in the middle of the parenchyme, below the palisade-cells, or in contact with the epiderm.

The presence of the continuous laticiferous tubes above described does not exclude that of articulated tubes in the same plant; the formation of the former may precede that of the latter.

Membrane of Bast-cells.*—Herr C. Mikosch has observed a structure of the membrane of bast-cells in *Apocynum Venetum* which he considers confirmatory of Wiesner's view † of the origin of the particles of the cell-wall from plasomes; the structure is similar to that described by Strasburger in *Vinca major*. In addition to the usual thickening-layer consisting of numerous lamellæ, there is an inner one sharply differentiated from it, composed of a number of nearly parallel rods placed at right angles to the axis of the cell. While the outer layer is composed of pure cellulose, micro-chemical tests show that the composition of this inner layer is not so simple. Very long treatment with concentrated sulphuric acid or ammonium copper oxide discloses the presence in the rods of granules which are evidently identical with Wiesner's dermatosomes. The author sees no other possible explanation of the structure observed but that protoplasm takes part both in the formation and in the growth of the cell-wall.

Commenting on this paper Herr E. Hanausek ‡ points out that the presence of an inner layer in bast-fibres has been already described by himself and others in numerous instances. As a reagent for its demonstration he prefers sulphuric acid and iodine, and considers that the reaction indicates the presence in it of albuminoids.

Arrangement of Secretory Canals.§—M. P. Van Tieghem confines his researches on this subject to three natural orders, Dipterocarpeæ, Simarubæ, and Liquidambareæ. In his conclusions the author states that the primary secretory canals in these three orders belong, in the stem and root, to the periphery of the pith, and in the leaf to the periphery of the medullary region of the peridesm. The Liquidambareæ differ from the Dipterocarpeæ and Simarubæ in possessing circummedullary secretory canals beneath the phloem in the root. The Dipterocarpeæ resemble the Simarubæ in the arrangement of their secretory canals, but are easily distinguished by their stratified phloem. Among the Dipterocarpeæ, *Dryobalanops aromatica* is worthy of note, as it has in its petiole, besides the medullary canal of its median bundle, four external pericycle or cortical canals; and it is pointed out by the author that the genus *Leitneria*, which was placed among the Urticacæ by Bentham and Hooker, and among the Cupuliferæ by Baillon, agrees with the Dipterocarpeæ in the arrangement of its secretory canals.

Limit of the Stem and Root in the Hypocotyledonary Region.||—M. P. Van Tieghem states that the hypocotyledonary region of the embryo consists of two parts: the base of the stem or *tigel*, and the base

* Ber. Deutsch. Bot. Gesell., ix. (1891) pp. 306-12.

† Cf. this Journal, 1891, p. 207. ‡ Ber. Deutsch. Bot. Gesell., x. (1892) pp. 1-4.

§ Journ. de Bot. (Morot), v. (1891) pp. 377-88.

|| Tom. cit., pp. 425-8.

of the root or *rhizel*. The rhizel and radicle compose the root, while the tigel and gemmule constitute the stem. Four different methods of germination may be observed in Dicotyledons and Gymnosperms. The cotyledons may remain hypogeous, as in Monocotyledons; or they may grow and expand in the air and the light. The growth may take place in the tigel (as in *Ricinus*, *Acer*, *Cucurbita*, *Tagetes*, *Convolvulus*, &c.); or in the tigel and rhizel (*Euonymus*, &c.); or only in the rhizel, which seems to take place most frequently, as in Ranunculaceæ, Cruciferæ, Caryophyllaceæ, Chenopodiaceæ, Umbelliferæ, Rubiaceæ, Coniferæ, &c.

Origin of Polystely in Dicotyledons.*—Dr. D. H. Scott points out that, while a polystelic structure of the stem is common in Vascular Cryptogams, occurring in the majority of ferns and in many species of *Selaginella*, in Phanerogams the monostelic structure is universal, except in two widely separated genera, *Auricula* and *Gunnera*. These two genera, however, resemble one another in having near relations which are aquatic in habit, and which have the reduced vascular structure characteristic of aquatic plants. Dr. Scott suggests that these polystelic Dicotyledons owe their exceptional structure to descent from aquatic ancestors, and that it may be regarded as the anatomical expression of the return of plants of aquatic habit to a terrestrial mode of life.

Endings of the Vessels in the Leaves.†—By macerating leaves for a long time in water, and then clearing with strong potash-lye, Herr P. Krutickij finds that the finest ends of the bundles are composed of two kinds of elements, tracheids, and long slender tubular cells, connected directly with the phloem of the stouter bundles, and not of tracheids only, as has generally been stated. The rows of these cells are in direct contact with the rows of tracheids only in one spot, which is near the end of the bundle; the remainder lie free in the parenchyme, near to the tracheid-bundle, and parallel to it. This observation is of considerable physiological importance in connection with the conduction of plastic substances from the leaves.

Extra-phloem Sieve-tubes in the Root of *Lythrum*.‡—Mlle A. Fremont records the occurrence of extra-phloem sieve-tubes in the root of *Lythrum Salicaria*. They have also been observed by Van Tieghem in several Monocotyledons, and among Dicotyledons in *Cucurbita* and *Vinea*, by Scott in *Strychnos* and *Chironia*, and by the author in *Epilobium*.

(4) Structure of Organs.

Variations in Floral Symmetry.§—Mr. W. Bateson and Miss A. Bateson record a series of observations on variations in the floral symmetry of certain plants with irregular corolla, the species observed being mainly *Linaria spuria*, *Veronica Buxbaumii*, hybrid *Gладиoli*, and species of *Streptocarpus*. As a general result, the law is stated that variations which occur in such a manner as to produce a symmetrical result may

* Ann. of Bot., v. (1891) pp. 514-7.

† VIII. Congr. Russ. Naturf. u. Aertze (Bot.), 1890, pp. 60-2. See Bot. Centralbl., 1891, Beih., p. 417.

‡ Journ. de Bot. (Morot), v. (1891) p. 448. Cf. this Journal, 1891, p. 618.

§ Journ. Linn. Soc. (Bot.), xxviii. (1891) pp. 386-424 (2 pls.).

be great variations, and may be perfect; while, conversely, variations which are large do often produce symmetrical results. Again, the perfection or completeness in which a variation in symmetry occurs is not, or at least need not be, proportional to the frequency of the occurrence of the variation. A large number of the variations which occur in nature—especially the occurrence of peloria, or regular flowers in species normally irregular—are abrupt or discontinuous; these are apparently not reversions to an ancestral type, and can afford no assistance in tracing the evolution of the species.

Pseudanthy of the Flowers of *Camellia* and *Geum*.*—According to Sig. U. Bernaroli and Prof. F. Delpino, an examination of the origin and course of the vascular bundles in the flower of *Camellia* shows that the andrœcium is composed of five androphores (phalanges or male inflorescences) springing from the axils of the petals, and not from the axils of the sepals as in the Malvaceæ, Hypericaceæ, and Rosaceæ; in addition to these are two or three lateral androphores, apparently of independent origin. At an early period each of the five androphores divides tangentially into two branches, which again divide polytomously, and not dichotomously as in the Euphorbiaceæ, Malvaceæ, and Hypericaceæ. The two or three supplementary androphores are probably the axillary product of corresponding abortive petals. The flowers of *Camellia* are therefore pseudanthic, though the pseudanthy is developed in a different way from that of the Malvaceæ. The same conclusion is derived from the examination of abnormal flowers.

In the greater number of the Rosaceæ an examination of the origin and course of the vascular bundles in the flowers is attended with great difficulties, owing to the confined space in which the vascular network of the receptacle branches; but *Geum urbanum* and its allies present more favourable subjects. Here, also, the andrœcium is composed of five male monopodial polytomous inflorescences, not dichotomous as in the Malvaceæ, each of which springs from the axis of a sepal. Each petal has a double origin, representing the union of two bracts, one belonging to the male inflorescence on the right, the other to the male inflorescence on the left. In *Geum* every sepal is three-nerved; and the leaves of the outer calyx are evidently also double organs resulting from the fusion of the left stipule of the right-hand sepal with the right stipule of the left-hand sepal; and the so-called median nerve is not in reality a median, but a sutural nerve.

Flower of *Iochroma*.†—Prof. G. von Lagerheim describes the peculiar structure of the flower of *Iochroma macrocalyx* (Solanaçæ) from Ecuador. The space between the calyx and the corolla is filled with a quantity of clear water, which serves to prevent the drying up of the buds, and also to protect the honey from the too vigorous assaults of the humming birds which feed upon it. The fluid appears to be secreted from glandular hairs on the inside of the calyx.

"Sling-fruit" of *Cryptotænia*.‡—Mr. E. J. Hill describes the mechanism by which the mericarps or half-fruits of *Cryptotænia cana-*

* Malpighia, v. (1891) pp. 145-55 (1 pl.). Cf. this Journal, 1891, p. 213.

† Ber. Deutsch. Bot. Gesell., ix. (1891) pp. 348-51 (9 figs.).

‡ Bot. Gazette, xvi. (1891) pp. 299-302.

densis (Umbelliferae) are thrown to a distance of 5 or 6 feet from the plant. When ripe the mericarps become detached from the carpophore for the greater part of their length, only a small portion of them adhering to its apex. Under the force of a sudden blow, the mericarp becomes completely released, while the adhesion at the top is strong enough to turn the fruit over when released; and it is thus slung from its support, and propelled, the lower end foremost.

Funicle of Seeds.*—From the examination of a number of seeds—*Pisum sativum*, *Vicia Faba*, *Brassica Napus*, *Papaver somniferum*, *Nicotiana Tabacum*, &c.—Herr M. Dahmen draws the following conclusions. The main object of the funicle, and its invariable function, is to furnish a path for the conduction of nutrient tissue to the growing seed; but it may also serve to assist the detachment of the ripe seed from the pericarp. The tissue of the funicle is commonly differentiated into epiderm, phloem, xylem, and spongy parenchyme; sclerenchymatous cells are also sometimes present. The fibro-vascular bundle is never branched, and the xylem consists exclusively of spiral tracheids. The cells contain proteids, usually sugar and starch, and occasionally raphides, mucilage, fatty and essential oils, and chromoplasts. The conduction of the nutrient substances takes place mainly through the parenchyme and the epiderm; and the phenomena observed are favourable to the theory that the phloem is rather a reservoir for food-material than one of the main agents in its conduction.

Seeds of Rhamnus and Coccoloba.†—Herr G. Lindau describes the structure of the mature seeds and of the fruit of *Rhamnus catharticus* and *Coccoloba populifolia* (Polygonaceae), which have this peculiarity in common; that the endosperm of the ripe seed exhibits one (*Rhamnus*) or more (*Coccoloba*) furrows, which originate not in the endosperm itself, but in the integuments; depressions are formed in the integument, into which the endosperm forces itself.

Specific Characters in Eucalyptus.‡—Messrs. D. McAlpine and J. R. Remphrey give descriptions and drawings of transverse sections of the petiole of a number of species of *Eucalyptus*, from which they state that in many cases specific characters can be drawn. These characters depend on the relative thickness or thinness of the epiderm, the number, size, and arrangement of the cortical cavities, the appearance of the central canals, and other points of structure.

Mr. A. W. Howitt§ describes and classifies the species of *Eucalyptus* growing in Central and Western Gippsland, and has remarks on their distribution in area, altitude, and geological formation, the influence of climate and geological formation on the distribution of types, and that of human settlement on the *Eucalyptus* forests.

Leaves of Liriodendron.||—Mr. T. Holm points out the great variability of the leaves of the tulip-tree, *Liriodendron Tulipifera*, according to their position on very young or on older branches. The difference

* Jahrb. f. Wiss. Bot. (Pringsheim), xxiii. (1891) pp. 441-78 (3 pls.).

† Ber. Deutsch. Bot. Gesell., ix. (1891) pp. 274-9 (1 pl.).

‡ Trans. Roy. Soc. Victoria, ii. (1890) pp. 1-64 (7 pls.).

§ Tom. cit., pp. 81-120 (9 pls.).

|| Proc. U.S. National Museum, xiii. (1890) pp. 15-35 (6 pls.).

is quite as great as that between many of the extinct species of *Liriodendron*. Of these, as many as fourteen have been described, besides varieties, the fossil remains or impressions being found in the Cretaceous and Tertiary strata. The author thinks it probable that the genus may have been derived from certain forms of *Magnolia*.

Swollen Roots of Monocotyledons.*—M. L. Daniel discusses the structure and function of the napiform or dauciform roots or "pseudorhizes" which occur abundantly in many bulbous Monocotyledons, especially *Crocus* and *Gladiolus*. He considers these to be not accidental, but normal, though transitory structures, formed for the purpose of storing up food-material, whenever from either external or internal causes the ordinary structures are unable to supply sufficient nutrition, as, e. g. during excessive dryness. They are either solitary or are formed in pairs or groups, and are abundantly provided with absorbing hairs, presenting, in their structure, a close approximation to that of true roots. In *Gladiolus* the transitory reserve-substance is glucose.

β. Physiology.

(1) Reproduction and Embryology.

Fertilization of the Casuarineæ.†—From observations made by Dr. M. Treub on several species of *Casuarina*, especially *C. suberosa*, he arrives at the remarkable conclusion that the mode of fertilization differs essentially from that which takes place in the rest of Flowering Plants.

The female flower is composed of two carpels; there is a single small ovary, surmounted by a massive axial structure, corresponding to the style in other plants, and terminating in two stigmas. As soon as the ovarian cavity is formed it closes completely, and in it appear two parietal ovules, united by strings of cellulose to the base of the axial structure or summit of the ovarian cavity; the point of adherence is called by M. Treub the bridge; and the ovule adheres to the ovarian cavity below by the funicle, above by the bridge.

In the development of the ovule, certain large hypodermal cells, the archesporium-cells, at the summit of the nucellus, divide tangentially; two of the cells produced on the inner side, the primordial mother-cells, divide further into a cylinder which occupies the centre of the nucellus, the sporogenous tissue, surrounded by flattened cells, the tapetal cells; the cells of the sporogenous tissue correspond to the mother-cells of the embryo-sac of other Angiosperms. They divide transversely into large megaspores; the small inactive cells usually become absorbed; while in *C. glauca* and *Rumphiana* tracheids are formed, possibly comparable to the claters in the Hepaticæ. The megaspores, of which there are usually from sixteen to twenty, elongate towards the chalaza, and some of these penetrate between the elements of the vascular bundle of the funicle.

Most of the megaspores which develop have at their extremity two or three naked sexual cells resulting from the division of a single cell; usually there is one, and only one, megaspore in each nucellus which

* Rev. Gén. de Bot. (Bonnier), iii. (1891) pp. 455-61.

† Ann. Jard. Bot. Buitenzorg, x. (1891) pp. 145-231 (21 pls.).

has these sexual cells inclosed in cell-walls of cellulose. This is the future embryo-sac. There are no antipodals.

Only a single ovule in each ovary is fertilized. The pollen-tube which impregnates it descends the axial stylar cylinder, crosses the bridge and the tissue which unites the ovule with the wall of the ovary, traverses the chalaza, and becomes ruptured about the middle of the nucellus, the apical portion being the only one which takes part in fecundation. This portion never enters the micropyle nor the embryo-sac, but becomes firmly attached to the wall of the latter at a point at some distance from the sexual apparatus; but the actual process of impregnation has not as yet been observed. During the development of the embryo-sac numerous endosperm-nuclei are formed, and subsequently the embryo makes its appearance. Its development resembles that in normal Dicotyledons.

M. Treub regards these facts as sufficient to warrant the separation of the Casuarinæ as a distinct primary section of Angiosperms, to which he gives the name CHALAZOGAMS, classing the Monocotyledons and Dicotyledons together under the term POROGAMS. The Chalazogams are not intermediate between Gymnosperms and Angiosperms, but constitute the lowest division of the latter.

The preparations were treated with eau-de-Javelle, and stained by Bismarck-brown.

Pollen-tube of Gymnosperms.*—Herr W. C. Belajeff contests the ordinary view that it is the larger cell alone in the pollen-grain of Gymnosperms that takes part in the process of impregnation, or, indeed, that it is the true generative cell. The observations were made chiefly on *Taxus baccata*.

The ripe pollen-grain of Gymnosperms consists of one large and several small cells; the latter are cut off in succession from the large cell, which is an argument against the theory that they are the survival of a male prothallium. At the time of fertilization there are found—surrounding the two nuclei resulting from the bipartition of the nucleus of the larger cell, which has wandered to the extremity of the tube—a number of small cells, which are generally stated to have been formed at the spot where they are found. This view the author believes to be incorrect.

One of the small cells resulting from the division of the large cell, the anterior one, does not become resorbed, as is generally stated; but, in the course of development of the pollen-tube, wanders to its extremity, in company with the nucleus of the large cell; the other posterior small cell breaks up, but its nucleus becomes detached, and also takes the same course. The end of the pollen-tube swells up, and often puts out outgrowths in various directions. The nucleus of the small cell overtakes the wandering cell; the latter rounds itself off, increases in size, and its nucleus divides into two. In the process of fertilization it appears to be one of the daughter-nuclei of this wandering cell, together with the protoplasm that surrounds it, that pass into the oosphere; the other daughter-nucleus, with the membrane, remains in the pollen-tube. The fate of the nucleus of the large cell could not be determined.

* Ber. Deutsch. Bot. Gesell., ix. (1891) pp. 280-6 (1 pl.).

The process appears to be similar in *Juniperus communis*; but here one pollen-tube serves for the impregnation of several oospheres.

Constriction and Partial Obliteration of the Embryo-sac.*—Herr F. Hegelmaier describes the peculiar processes which take place in the development of the embryo-sac of various species of *Linum* (*catharticum*, *flavum*, *austriacum*, *grandiflorum*, *angustifolium*, and *usitatissimum*). In the two last-named species the embryo-sac, in the course of its development, broadens chiefly at its upper (oosphere) end, the lower (antipodal) end remaining comparatively narrow, and these two portions become gradually separated from one another by a constriction. The upper portion contains the embryo, and in it alone formation of endosperm takes place. The narrower portion becomes eventually entirely separated, still inclosing the antipodals, and, in its upper part, a number of nuclei, the origin of which is doubtful. It at length becomes compressed by the growing fertile portion of the sac, and almost unrecognizable. In *L. grandiflorum* the process is similar, except in the different shape of the sterile portion of the sac.

In *L. catharticum* the process is somewhat different. No constriction of the embryo-sac takes place; but its lower portion becomes obliterated, and converted into a solid curved cord, the remains of the antipodals being still visible in the fertile portion. *L. flavum* presents similar phenomena.

A third mode of obliteration occurs in *L. austriacum*. A constriction is formed in a mode similar to that in the first-named species; but the separation of the two parts of the embryo-sac is only temporary, a portion of the contents of the upper part being subsequently again forced into the lower part.

The nuclei found in the upper part of the sterile portion may either have arisen independently, or they may be products of division of the antipodals or of the original nucleus of the endosperm.

Cleistogamy in Polygonum.†—Mr. T. H. Kearney confirms Mr. Meehan's observation of the existence of cleistogamous flowers in *Polygonum acre*, on branches either underground or only just above the surface of the soil.

(2) Nutrition and Growth (including Germination, and Movements of Fluids).

Assimilation by the Mistletoe.‡—According to Prof. G. Bonnier, the relationship between the mistletoe and the tree (apple-tree) on which it grows, is not one of simple parasitism, but rather one of symbiosis. He found that in the summer, at a temperature varying between 15° and 35° C., the leaves of the mistletoe disengage per weight about 1/6, or per surface about 1/3, as much as the leaves of the apple; and the former must therefore depend, for the larger part of its nutriment, on its parasitism on the latter. In the winter, however, the conditions are reversed; and, by a series of experiments on the dry weight, Prof.

* Ber. Deutsch. Bot. Gesell., ix. (1891) pp. 257-66 (1 pl.).

† Bot. Gazette, xvi. (1891) p. 314 (1 fig.). Cf. this Journal, 1889, p. 781.

‡ Bull. Soc. Bot. France, xxxvi. 1891, Actes du Congrès de Bot., 1889, pp. cclxxiii-iv.

Bonnier was able to determine that the increase in weight of the mistle-toe is less than the amount of carbon which it has obtained from the atmosphere; in other words, that it gives up a portion of its assimilated substances to its host.

Assimilation by Parasitic Plants containing Chlorophyll.*—Prof. G. Bonnier shows in what manner the chlorophyll, which certain parasitic plants contain, can lessen or even annul their parasitism. The following are his conclusions:—(1) From a physiological point of view, parasitic plants containing chlorophyll present all intermediate stages between a plant which is totally dependent on its host, and a plant which profits only by the mineral substances taken up by the roots of the host. (2) In certain cases there is a reciprocal exchange of assimilated substances between host and parasite. (3) One cannot always deduce the anatomical structure of a plant from its physiological functions. Thus two plants in the same family, *Melampyrum* and *Euphrasia*, possess similar chlorophyllaceous tissues, but have a very different power of assimilation. *Thesium humifusum* and certain species of *Pedicularis* have leaves of a deep green, but their assimilation is much less intense than that of *Melampyrum*.

Physiology of Seeds.†—Herr A. Tschirch gives a record of a series of observations on the nutritive process in the seed, chiefly in relation to tropical Monocotyledons. The following are the more important results.

All seeds of Monocotyledons which have a tissue containing a store of food-material (endosperm or perisperm) have an absorbing organ which remains in the seed during germination, and absorbs the nutrient tissue. This organ is, in the dormant seed, either scutellum-like (Gramineæ-type), or clubshaped, leaf-like or filiform (Zingiberaceæ-type), or short and of indefinite form, when it increases rapidly during germination, and forces its way into the endosperm (Palm-type). The epiderm of the absorbing organ is sometimes provided with papillæ, sometimes not. The absorbing organ corresponds to a similar organ in Gnetaceæ and Cycadeæ, and possibly to the "foot" of the embryo in Vascular Cryptogams, and to the "foot" of the capsule of mosses. In the families of Monocotyledons destitute of endosperm (Helobiæ and Naiadeæ), the organ which forms a sheath round the plumule is certainly a cotyledon, while, on the other hand, in the second and third types, the absorbing organ and the cotyledonary sheath (pileole or coleoptile) together constitute the cotyledon, which therefore consists of a sheathing portion, at first enveloping the plumule, of an absorbing portion which remains in the seed, and of an elongated portion or neck which unites the two former.

Even in the Gramineæ-type, and in seeds with "swollen hypocotyl," the pileole is the cotyledon; while the morphological interpretation of the scutellum and of the "swollen hypocotyl" is doubtful. The cotyledon of *Ruppia*, *Pothos*, &c., the "germinal tubercle" of Orchideæ, and the "protocorm" of Lycopodiaceæ, appear to be functionless absorbing organs. In some families of Monocotyledons, the seed is furnished

* Comptes Rendus, cxiii. (1891) pp. 1074-6.

† Ann. Jard. Bot. Buitenzorg, ix. (1891) pp. 143-83 (6 pls.).

with fleshy structures, which serve to assist its germination and the complete absorption of its nutritive tissue.

Chlorescence of Plants.*—M. E. Belzung refers to the result of Palladin's researches on the chlorescence and growth of etiolated leaves, viz., that without sugar, chlorophyll could not develop in a plant, as confirming his own view on the relation between the starch-grain and the grain of chlorophyll.

M. Belzung gives the substance of further observations on the formation of starch and the use that is made of it. From a fact observed by M. Bokorny in *Spirogyra majuscula* the conclusion is drawn that the formation of starch is not solely due to the carbon and the elements of water, but to the production of various complex organic substances, and to the intervention of several other elements, such as nitrogen, potassium, &c.

Effect of Exposure on the relative length and breadth of Leaves.†—Mr. G. F. Scott Elliot has made a series of observations on variations in the leaf-ratio, i.e. the relation between the length and breadth of leaves—produced by various conditions of soil and atmosphere. The general result is that exposure (in other words increase of transpiration) has a tendency to lower the leaf-ratio, that is, to increase the breadth of leaves in proportion to their length. A large number of the observations were made on tropical grasses, and it was found that in them the lowest leaves, which are most protected from wind and sun, are proportionately the longest. Similar results were obtained by growing the same species in more and in less sheltered situations. Experiments on growing the same species in different soils led to no very definite results.

Fixation of Free Nitrogen by Plants.‡—MM. T. Schlösing and E. Laurent describe certain experiments in which the amount of free nitrogen used by various plants is ascertained. There are two methods, the direct method and the indirect. The former is without doubt superior, and consists in ascertaining the amount of gaseous nitrogen at the commencement and at the termination of each experiment. The author's conclusions are:—(1) That certain of the lower green plants obtain gaseous nitrogen from the atmosphere. (2) That in the experiments no measurable amount of nitrogen was fixed by either mustard, cress, or spurrey, &c., but peas under the same conditions do absorb large amounts of nitrogen from the atmosphere.

Nitrogen Assimilation of the Leguminosæ.§—The objects of the experiments on the above subject carried on by Herren F. Nobbe, E. Schmid, L. Hiltner, and E. Hotter were (1) to comprise some kinds of papilionaceous woody plants, (2) to infect with pure cultivations of bacteria from (a) soil and (b) root nodules, as well as with soil extracts, (3) to ascertain whether one and the same bacterium produces nodules in all leguminous plants, or whether the various orders have their

* Journ. de Bot. (Morot), v. (1891) pp. 350-5. Cf. this Journal, 1891, p. 758.

† Journ. Linn. Soc. (Bot.), xxviii. (1891) pp. 375-85.

‡ Comptes Rendus, cxiii. (1891) pp. 776-8. Cf. this Journal, 1891, p. 771.

§ Landw. Versuchs-Stat., xxxix. pp. 327-59. See Journ. Chem. Soc., 1891, Abstracts, p. 1533. Cf. this Journal, 1891, p. 209.

special organisms. The first series of experiments included *Pisum sativum*, *Robinia Pseudacacia*, *Cytisus Laburnum*, and *Gleditsia triacanthos*. The results obtained confirmed those of Hellriegel that the nodule bacteria give an impetus to vegetation, and hinder the formation of flower and fruit. All the successfully infected plants had nodules which varied in size and number in the different plants experimented upon. Thus in *Robinia* the nodules were generally larger but less numerous than on pea-roots. The quantitative results, amount of dry produce, and the amount of nitrogen in produce and in seed sown, are carefully given in several tables which accompany the paper.

(3) Irritability.

Nutation of the Sunflower.*—Mr. W. A. Kellerman has observed the phenomena of nutation in a very large number of sunflowers; and finds it displayed more or less in 66 per cent. of the specimens observed, 34 per cent. not exhibiting any movement. In those which displayed nutation, the direction of the movement was very various, as also its intensity, very few approaching a semicircle.

(4) Chemical Changes (including Respiration and Fermentation).

Limits to the Accumulation of Carbohydrates in the Leaf.†—From a series of experiments on the leaves of *Vitis vinifera* and *Labrusca*, and *Rubus fruticosus* and *cæsius*—leaves which remain fresh in direct sunshine, if the stalks are placed in water, for as long as ten days after they have been gathered—Herr W. Saposchnikoff ascertained that sugar may accumulate in the cell-sap to as high a concentration as 6.8 per cent., while, on the other hand, the conversion of sugar into starch commences at a concentration of 2 per cent. It would appear therefore that two opposite processes are going on in the leaf at the same time, the formation of starch out of sugar, and the conversion of starch into sugar. The weaker the concentration of the sugar, the more quickly is the starch dissolved, and *vice versa*. There is a degree of concentration—near the maximum amount of sugar in the leaf—at which there is an equilibrium between the two processes; and in this condition no further increase of the sugar takes place.

Influence of Phosphoric Acid on the Formation of Chlorophyll.‡—By a series of experiments on Algæ, chiefly *Spirogyra*, Dr. O. Loew claims to have established that not only iron salts, but also phosphates, are essential to the formation of normal chlorophyll.

Ripening of Cherries, Fermentation of Cherry and Currant Juice, and Colouring-matters of Red and Black Currants.§—Herr W. Keim deals in the first part of this paper with the change in chemical composition which takes place during the growth and ripening of the fruit of *Prunus Cerasus*. The results are tabulated, and show a progressive increase in the percentage of acids and invert sugar. Succinic acid

* Trans. Kansas Acad. Sci., xii. (1890) pp. 140–58. See Bot. Centralbl., 1891, Beih., p. 415.

† Ber. Deutsch. Bot. Gesell., ix. (1891) pp. 293–300.

‡ SB. Bot. Ver. München, Dec. 14, 1891. See Bot. Centralbl., xlviii. (1891) p. 371.

§ Zeitschr. Anal. Chem., xxx. pp. 401–7. See Journ. Chem. Soc., 1891, Abstracts, p. 1539.

disappears as ripening is approached; and this suggests the theory that the other acids are formed synthetically from oxalic and succinic acids. No starch was detected at any stage in the fruit itself. After various analyses and a comparison of the absorption spectra, the author states that the colouring matters of black and red currants are closely allied if not identical.

Nitrification.*—Herr J. Wortmann sums up the results of the recent researches on this subject of Schlösing and Müntz, Frank, Adametz, Warington, Frankland, Winogradsky, and others. He states that Winogradsky's observations have had, as one of their results, to overthrow at a blow one of the generally accepted theories of vegetable physiology, that it is only the chlorophyll-containing cells that are able to assimilate carbon dioxide.

γ. General.

Vegetable Perfumes.†—Dr. M. Buchner describes the method of obtaining the fragrant vegetable essential oils in exhausted vessels at the ordinary or at very low temperatures. He states that the most of these oils consist either of terpenes with the formula $C_{10}H_{16}$, or of polyterpenes with the formula $(C_5H_8)_x$.

Fructification of Bennettites.‡—Herr Graf zu Solms-Laubach has made a careful examination of the fructification of the fossil *Bennettites Gibsonianus* from the Isle of Wight. He has come to the conclusion that all the Jurassic and Neocomian stems which are termed *Cycas*-stems, so far as anything is known of their structure, belong to *Bennettites* rather than to the genuine *Cycadææ*. He regards the *Bennettitææ* and the *Cycadææ* as co-ordinate groups, with probably a close relationship to one another, but probably both derived from a common stock, and not one from the other. The author is further of the opinion that Saprota's class of Proangiosperms cannot represent a well-defined group in the genetic system, but must consist of members of different analogous developmental series, which have undergone evolution of a similar kind.

B. CRYPTOGRAMIA.

Cryptogamia Vascularia.

Antherozoids of Cryptogams.§—M. W. Beliajeff has come to a somewhat different conclusion from that of Guignard || with regard to the origin of the antherozoid in *Muscineæ*, *Characeæ*, and *Vascular Cryptogams*. His observations were made chiefly on *Filices* and *Characeæ*.

In *Filices* he finds that the body of the antherozoid is composed of a distinct chromatic filament, and of an achromatic ground-substance; and that the two extremities of the antherozoid do not contain chromatin. The anterior portion, and probably the entire achromatic substance of

* Landwirthsch. Jahrb., xx. (1891) pp. 175-84. See Bot. Centralbl., 1891, Beih., p. 476. Cf. this Journal, 1891, pp. 83, 680.

† MT. Naturw. Ver. Steiermark, 1891, pp. lxiv.-lxxi.

‡ Bot. Ztg., xlviii. (1890) pp. 789-98, 805-16, 821-33, 843-6 (2 pls.), and Ann. of Bot., v. (1891) pp. 419-54 (2 pls.).

§ Scripta Bot. Hort. Petropol., iii. (1891) p. 104. See Malpighia, v. (1891) p. 229. Cf. this Journal, 1889, p. 785. || Cf. this Journal, 1889, p. 552.

the body of the antherozoid proceed from the cytoplasm of the mother-cell; the filament of chromatin from its nucleus.

In the Characeæ the two vibratile cilia are not attached to the anterior part of the body of the antherozoid, but further back. There is here also an achromatic portion and a chromatic filament, the latter being situated in that part which lies beneath the insertion of the cilia. The anterior portion of the antherozoid, with its cilia, and the posterior achromatic part of the body of the antherozoid, are derived from the cytoplasm of the mother-cell, the nucleus of which elongates and curves, and becomes the chromatic filament.

It is therefore not the nucleus only of the mother-cell which becomes the antherozoid in Musci, Characeæ, and Vascular Cryptogams, for its cytoplasm is the part from which the achromatic portion is formed.

Petiole of Osmundaceæ.*—M. G. Poirault finds that the vascular system of the petiole of the Osmundaceæ does not differ from that in other Ferns. There is always a double phloem, on the outer and inner side of the bundle, characterized by sieve-tubes with terminal strongly oblique septa, and punctations blocked by callus. In *Osmunda regalis* and *Todea pellucida* and *africana* the xylem, double phloem, and pericycle, are together completely surrounded by an endoderm, the cells of which have characteristic suberized markings on their radial faces.

Lepidodendron Harcourtii.†—M. C. E. Bertrand has made a careful examination of the structure of this fossil Vascular Cryptogam, and maintains that it does not exhibit any phanerogamic character. The presence of secondary fibrovascular formations does not necessarily indicate a phanerogamic structure. A point of difference is referred to between *Lepidodendron* and *Sigillaria*, in the ramification being axillary in the latter, independent of the axils of the leaves in the former genus.

Muscineæ.

Stem and Leaf of Mosses.‡—M. E. Bastit has made a series of careful observations on the stem and leaves of a great variety of mosses, from both an anatomical and a physiological point of view. The following are the more important results.

The underground stem of mosses differs in structure from the aerial stem, and is characterized by the localization of the generative tissues, the vascular bundles, and the hypoderm. Its growth is indefinite. It has three bundles or groups of bundles, each corresponding to an angle; and each is continued into the nerve of a scale. The scale is a brown foliar organ, the lamina of which, composed of a single layer of cells, is always more reduced than that of the leaf, and always sheaths the stem. The aerial stem has an indefinite growth; its anatomical structure is of four different types, viz.:—(1) The *Sphagnum*-type; a uniform parenchyme limited by a zone of large aquiferous cells; (2) The *Thuidium*-type; a uniform parenchyme limited by a layer of epidermal cells;

* Journ. de Bot. (Morot), v. (1891) p. 355. Cf. this Journal, 1891, p. 775.

† Trav. et Mém. des Facultés de Lille, ii., 159 pp. and 10 pls. See Bull. Soc. Bot. France, xxxviii. (1891) p. 257. Cf. this Journal, 1891, p. 776.

‡ Rev. Gén. de Bot. (Bonnier), iii. (1891) pp. 255-71, 306-16, 341-60, 373-88, 406-26, 462-87, 521-30 (2 pls. and 42 figs.). Cf. this Journal, 1891, p. 601.

(3) The *Mnium*-type; a parenchyme differentiated into a uniform central cylinder and a chlorophyllous parenchyme; (4) The *Polytrichum*-type; a central cylinder differentiated into a medullary band and a pericyclic zone. In some stems with central cylinder there are indications of branching. The epiderm of the underground stem is characterized by the presence of absorbing hairs, that of the aerial stem by the existence of an external cuticle and by the internal cutinization of the cell-walls. In the underground stem the cortical parenchyme always comprises a small number of layers, while the central cylinder is well developed; in the aerial stem, on the other hand, the cortex is more developed, and the central cylinder greatly reduced.

When an aerial moss is placed under aquatic conditions, the characters of the epidermal layer of the stem and those of the leaf undergo great modification. The epidermal cells increase in size, lose their cuticle; the cell-wall is composed of cellulose only, and is greatly reduced in thickness; changes also take place in the leaf.

If mosses are cultivated in the air or in water, and the conditions of illumination and of the position of the stem are varied, the stems are seen to be endowed with very feeble negative geotropic, and with strong positive heliotropic properties. The heliotropism is always preponderant, and the stems always direct their growth towards the source of light, whatever its direction. In a moist air the leaves of certain mosses take two positions on the stem;—one when the air is nearly saturated with moisture, the other when the air is comparatively dry; the latter is the closed position or that of sleep. The movements of the leaf from one of these positions to the other depend on the contraction or turgor of its chlorophyll-tissues.

In both states of the leaf mosses disengage carbon dioxide in the dark, but the process is less active in the sleep condition; and this is also true of the process of assimilation. The relation of the volume of carbon dioxide disengaged to that of oxygen absorbed is constant and normal. It is in the spring and the autumn, when mosses are moistest, that their vital functions are most active, and that the sexual organs and sporogones are formed.

Rabenhorst's Cryptogamic Flora of Germany (Musci).—In Parts 17 and 18 of this publication, the description of the Funariaceæ is completed, and that of the Bryaceæ commenced. In this family the genus *Mielichhoferia* is first separated as a distinct group characterized by its lateral inflorescence and fruit. The remaining genera, comprising the group Bryceæ, are *Leptobryum*, *Anomobryum*, *Plagiobryum*, *Webera* (20 sp.), *Minobryum*, *Stableria*, and *Bryum*. Of the latter genus, the subgenus *Cladodium* is alone included in these parts, itself including 47 European species. The woodcuts are of the usual excellence, the structure of the peristome being especially elucidated in the species illustrated.

Algæ.

Engler and Prantl's Natural Families of Plants (Algæ).—Of this important work four parts have now been published relating to Algæ, viz. Parts 40, 41, 46, and 60, including the Conjugatæ, Chlorophyceæ, and Characeæ, worked out by Prof. N. Wille, and the

commencement of the Phæophyceæ by Herr F. R. Kjellman. The following are among the more important of the details.

The Conjugatæ are arranged under the three classes Desmidiaceæ, Zygnemaceæ, and Mesocarpacææ. The Desmidiaceæ are divided into 31 genera; the genera of Zygnemaceæ are *Zygnema*, *Spirogyra*, *Debarya*, (*glyptosperma*), and *Zygogonium*; of Mesocarpacææ, *Mougeotia* and *Gonatonema*.

The Chlorophyceæ are also divided into three classes, Protococcoidææ, Confervoidææ, and Siphonææ; and these again into 25 families. The Protococcoidææ include the six families Volvocaceææ, Tetrasporaceææ, Chlorosphaeraceææ, Pleurococcaceææ, Protococcaceææ, and Hydrodictyaceææ; the Volvocaceææ are again divided into Chlamydomonadeææ, Phacotæææ, and Volvocæææ, the Protococcaceææ into Endosphaeræææ, Halosphaeræææ, and Characiæææ. Several generally accepted genera are suppressed, some being regarded as states of other Chlorophyceæ, e. g. *Protococcus*, *Palmella*, and *Glæocystis*, others as belonging to other groups; thus *Porphyridium* is placed in the Phycochromaceææ, *Hydrurus* in the Phæophyceææ or Flagellataææ.

The Confervoidææ are classified into those genera in which the vegetative cells have only one nucleus, and those in which they have more than one; and then into those which produce zygospores and those which produce oospores. *Protoderma* and *Prasiola* are treated as doubtful Ulvaceææ. The Chætophoraceææ are divided into Chætophoreæææ, Chroolepideæææ, and Phæothamniæææ. The Mycoideaceææ are made up of the genera *Chætopeltis*, *Pringsheimia*, *Dermatophyton*, *Phycopeltis*, and *Mycoidea*; *Phyllactidium* belongs partly to *Stigeoclonium*, partly to *Chætopeltis*. *Pithophora* and *Spongocladia* are included among Cladophoraceææ; *Conferva* and *Microspora* under Ulotrichaceææ.

Under the Siphonæææ, Phyllosiphonaceææ (*Phyllosiphon Arisari*) forms a distinct family. The Valoniaceææ are divided into the two families, Valoniæææ and Anadyomenæææ, the former comprising the genera *Apjohnia*, *Blastophysa*, *Valonia*, *Dictyosphaeria*, *Siphonocladus*, and *Chamædoris*, the latter *Struvea*, *Microdictyon*, *Cystodictyon*, *Anadyomene*, and *Boodlea*. The Dasycladaceææ are classified under Acetabulariæææ and Dasycladeæææ, the former comprising *Polyphysa*, *Halicoryne*, and *Acetabularia*, the latter *Dasycladus*, *Chlorocladus*, *Botryophora*, *Neomeris*, *Bornetella*, and *Cymopolia*, in addition to the fossil genera.

In the classification of Characeææ there is nothing fresh. A general classification of Phæophyceææ is given, and Part 60 carries on the description of the separate families as far as the Ectocarpaceæææ, Choristocarpaceæææ, and the commencement of Sphacelariaceæææ.

Under each family a full account is given of the non-sexual and sexual organs and modes of multiplication, the geographical distribution, and the genetic relationships. Then follows the classification of the genera, and a diagnosis of each genus. The more important literature relating to each group is cited; the illustrations are numerous and very well executed; many of them quite new to English readers.

Thorea.*—Prof. M. Moebius describes a new species of *Thorea*, *T. andina* from Ecuador, and gives his adhesion to the older view that

* Ber. Deutsch. Bot. Gesell., ix. (1891) pp. 333-44 (1 pl.).

the genus belongs to the Florideæ (Batrachospermeæ), rather than, as Schmitz and Kirchner suggest, to the Phæosporææ. The following are the chief points of structure on which this view is founded:—The violet or purple pigment, which corresponds to that found in several other fresh-water Florideæ, but to nothing known in the Phæophyceæ; also the starch-like granules, which are coloured red-brown by iodine. The nature of the membrane and of the protoplasmic connections of the cells. The non-motile naked spores. Similar structures occur, among the Phæophyceæ, only in the Tilopterideæ and Dictyotaceæ; and with these orders *Thorea* has certainly no genetic affinity. The absence of sexual organs of reproduction may simply be the result of imperfect knowledge, as has been the case with many other genera of Florideæ.

Turbinaria.*—Miss E. S. Barton gives a monograph of this genus of Fucaceæ (Sargasseæ), with the following generic diagnosis,—*Caulis simplex v. ramosus, folia et receptacula gerens; foliis petiolo tereti aut triquetro aut trialato, interdum in vesiculum intumescente, laminam peltatam triquetram v. orbicularem sustinente; receptacula racemosa v. corymbosa in axilla folii emergentia, dioica v. monoica, interdum hermaphrodita; radix fibrosa.* The number of species described is nine, of which three are new,—*T. Murrayana* from New Guinea, *T. tricostata* from Guadeloupe, and *T. dentata* from Macassar. The description of the morphological structure is taken chiefly from *T. conoides*. The thallus is well differentiated into stem, leaf, and root. The growth of the stem is apical, but the author is unable to determine whether it takes place by means of a single cell or a group of initial cells. The air-vesicles are regarded as in all cases metamorphosed leaves; they are formed by the rending apart of the central tissue in young leaves. The view is advocated that the "sterile conceptacles" which contain paraphyses only are of equal antiquity, from a phylogenetic point of view, with those which contain reproductive organs.

Caulerpa.†—Mr. G. Murray describes three new species of *Caulerpa*,—*C. Holmesiana* from Algoa Bay, *C. Fergusonii* from Ceylon, and *C. phyllaphlaston* from Yncatan; and gives reasons in favour of the view that the *Caulerpæ* are more nearly related to the Valoniaceæ, rather than to the verticillate Dasycladææ.

Reproductive Cells of Hydrodictyon.‡—Herr G. Klebs has undertaken a further examination of the formation and structure of the reproductive cells in *Hydrodictyon reticulatum*, and gives the following as the more important results attained.

The cells which are destined for non-sexual propagation become very finely granular; the grains of starch are absorbed, and its substance distributed through the whole of the chlorophyll-layer in an extremely fine form; the nuclei increase rapidly and become uniformly distributed. The green layer of protoplasm which contains the nuclei is penetrated by fissures which finally unite into a delicately branched system, so that it appears as if broken up into a number of bands united with one

* Trans. Linn. Soc. Lond., iii. (1891) pp. 215-26 (2 pls.).

† Tom. cit., pp. 207-13 (2 pls.).

‡ Bot. Ztg., xlix. (1891) pp. 789-98, 805-17, 821-35, 837-46, 853-62 (1 pl.). Cf. this Journal, 1891, p. 227.

another by threads; the fissures are filled up by finely granular protoplasm. These bands become further divided by constrictions or by fresh fissures. The final products thus formed, the zoospores, swell up and become mutually compressed into regular polygonal plates, the peripheral membrane disappearing. Each zoospore has a lateral clear spot, where the nucleus is situated, two cilia, and two pulsating vacuoles. Portions of the protoplasm remain unconsumed as peri-plasmatic remains.

The cell-membrane now begins to swell, and is forced inwards by the unelastic cuticle, and finally becomes ruptured and detached. The zoospores, freed from its pressure, begin to "swarm" while still connected with one another by fine threads, and consequently retaining their original position; they come to rest, surround themselves with a cell-wall, and form a regular net.

In those cells which are destined to form gametes, there is usually a strong contraction of the central green layer of protoplasm before the division, causing it to form a wide-meshed net interrupted by clear spaces, and usually of a yellowish-brown colour. The breaking up of this layer is effected in the same way as in the formation of zoospores, only that it is carried further, the products, which become the gametes, being smaller and completely separated from one another. The escape of the gametes is preceded by a swelling of the cell-wall, which however affects only an inner layer, while the outer layer, with the cuticle, remains unchanged. The outer layer is ruptured, and the inner layer projects in the form of a bladder. The mass of gametes, situated between the inner layer and the vacuole, then begin to "swarm," and become freed by the further swelling of the vacuole. They then conjugate in pairs.

The process of division of the protoplasm in the cells of *Hydrodictyon* of both kinds furnishes a typical instance of free-cell-formation, in which the daughter-cells do not, from the first, form a tissue in conjunction with the mother-cell.

Fungi.

Phylogeny of Fungi.*—Dr. F. de Tavel points out that in the Oomycetes we find a great degeneration in sexuality, which at length entirely disappears, probably as an adaptation to terrestrial existence, the sporangium itself of *Peronospora* being transformed into a spore or conid; and this occurs also in the Zygomycetes, where the zygospores of sexual origin are often replaced by azygospores. The Myxomycetes are allied to the Zygomycetes, in two series, corresponding to the types with sporangia and the types with conidia. At the end of the series of sporangiferous fungi are the Ascomycetes. They are related to the Mucorini through the Hemiasci. At the summit of the series of conidiferous fungi are the Basidiomycetes, which are again allied to the Zygomycetes through the Ustilaginæ and Tilletiæ. The sporangiferous fungi and the conidiferous fungi form two parallel series, often difficult to distinguish externally in their higher forms; both are non-sexual, and are derived from the sexual Zygomycetes, which again are allied to the sexual Algæ.

* Arch. Sci. Phys. et Nat., xxvi. (1891) pp. 512-5.

Fungus Parasites of the Vine.*—MM. P. Viala and C. Sauvageau describe certain fungus-parasites of the vine which occur in the United States. Four new species of Sphærospideæ are described:—*Pyrenochaeta Vitis*, *Phoma Farlowiana*, *Coniothyrium Berlandieri*, and *Diplodia sclerotiorum*. *Pyrenochaeta Vitis* has been observed in New England as far south as Texas, especially on *Vitis riparia*, *Labrusca*, *cordifolia*, and *æstivalis*. The organs of fructification are of two kinds; pycnids are the commonest, and there are also "spermogones." The "spermatia" are very small and colourless. *Coniothyrium Berlandieri* is confined to the south, and is found in Tennessee, the Indian Territory, Missouri, Arkansas, and Texas, on *Vitis Berlandieri*, *cinerea*, and *candicans*. *Diplodia sclerotiorum* occurs only on *Vitis Labrusca* in Columbia, New Jersey, Delaware, Maryland, and New York State. *Phoma Farlowiana* is found in the same regions, and in Canada, on *Vitis Labrusca* and *V. riparia*.

Hobsonia, a new Genus of Tuberculariæ.†—Mr. G. Massee gives the following diagnosis of this unpublished MS. genus of Berkeley's, belonging to the section Helicosporæ, of the family Tuberculariæ, of the Hyphomycetes:—Sporodochia verruciformia superficialia; conidia muco initio immersa, cylindracea, hyalina, in tubum spiraliter laxè convoluta, pluriarticulata. It is distinguished from other genera of the section by its multiseptate conids, arranged in a lax spiral forming a cylindrical or conical body.

New Parasitic Fungi on Crops.‡—Mr. F. D. Chester describes the following three new parasitic fungi, and the diseases caused by them:—*Colletotrichum Lycopersici*, causing anthracnose of the tomato; a *Septoria* allied to *S. Petroselinii*, causing spots on the leaves of celery; *Phyllosticta Citrullina*, which attacks the water-melon, causing almost complete failure of the crop.

Schwendener's Lichen-theory.§—Dr. Nylander returns to the attack on Schwendener's theory of the symbiosis of Lichens. He states that the hypothesis is clearly refuted by observing the formation and evolution of the gonids in the thalline granules which are adnate on the erect chondroid axes of *Stereocaulon* and the *Cladonii*. It can be clearly seen that the gonids arise in the cells of the glomerules themselves of the thallus, which are composed of the medulla and gonids, and at the same time of the cortical cells. The same is to be observed in the formation of gonimia in the cephalodia of some species of *Stereocaulon*. All the Schwendenerian "algæ" are, he asserts, lichens.

Ostracoblabe implexa.||—M. E. Bornet now identifies his *Ostracoblabe implexa*, described as growing on the calcareous shells of molluscs, with the hyphæ of the lichen *Verrucaria consequens*, which are therefore capable, under certain conditions, of living isolated, without being united

* Journ. de Bot. (Morot), v. (1891) pp. 337-41, 357-66 (1 pl.).

† Ann. of Bot., v. (1891) p. 509 (1 fig.).

‡ Bull. Torrey Bot. Club, xviii. (1891) pp. 371-4.

§ Nylander: 'Sertum Lichenæ' Tropiciæ e Labuan et Singapore, pp. 31-4. See Grevillea, xx. (1891) p. 60 (1 fig.).

|| Journ. de Bot. (Morot), v. (1891) pp. 397-400. Cf. this Journal, 1890, p. 365.

to any alga. His *Lithopythium gangliiforme* also bears a strong resemblance to the hyphæ of *Verrucaria calciseda* *; but M. Bornet has not been able absolutely to determine their identity.

Hansen on Pasteur's Pure Yeast.†—Herr E. C. Hansen, in an article entitled "What is Pasteur's pure yeast?" replies to the attacks of Duclaux and Velten, both of whom seem to prefer Pasteur's method for obtaining a pure yeast cultivation to that of the author.

Duclaux eventually limited his strictures, admitting that, as far as bottom yeast was concerned, the author had effected a reform in brewing, but maintained his position with regard to top yeast.

Velten's contention was that Hansen had made a bad mistake in introducing into brewery practice a yeast consisting of a single species or race, his (Velten's) view being that brewers' yeast was composed of several kinds. The author then proceeds to show that the method advocated by his critics not only fails to obtain a pure cultivation, but if any disease-yeast be present matters become worse, and that therefore this method is useless for practical brewing purposes.

The author then proceeds to show that Pasteur's method had in view the purification of yeast from bacteria, and did not take into consideration the action of yeast-fungi, the addition of tartaric acid to the saccharine medium being only intended for the suppression of the bacteria.

The author points out that the commonest and most dangerous diseases to which low-fermented beer is liable are caused by certain kinds of *Saccharomyces*, a fact which precluded the possibility of purifying the yeast by Pasteur's method.

The author's own researches further proved that under the term *Saccharomyces cerevisiæ* were included all sorts of top and bottom yeasts, from which the most suitable variety ought to be chosen. When put into practice, the value of these principles was soon recognized by the brewing trade.

New Genera of Uredineæ.‡—Prof. G. von Lagerheim describes four new genera of Uredineæ from Ecuador, viz.:—

Puccinosira. Nearly allied to *Endophyllum*, the teleutospores being abstricted in chains and surrounded by a pseudo-peridium; but they are two-celled, and intermediate cells are formed between them which remain attached as appendages to the base of the spores. *P. Solani* on a species of *Solanum*.

Chrysopsora. A connecting link between *Puccinia* and *Coleosporium*. Only pycnids and teleutospores are known. Each teleutospore-cell divides by three thin septa into four cells, from each of which is developed a unicellular promycele or sterigma, which abstricts from its apex a single large ovate sporid. *C. Gynoxidis*, on more than one species of *Gynoxis*.

Alveolaria. Occupies an isolated position from the structure and arrangement of its teleutospores, which only are known. The groups of spores form round, often concentric, or elongated groups, forming columns on the under side of the leaf or on the leaf-stalk; the spores are

* Cf. this Journal, 1891, p. 383.

† CR. Travaux du Laborat. de Carlsberg, iii. (1891) pt. 1.

‡ Ber. Deutsch. Bot. Gesell., ix. (1891) pp. 344-8.

flat round discs. Two species, *A. Cordiæ* and *audina*, both on species of *Cordia*.

Trichospora bears the same relation to *Cronartium* as *Chrysopsora* does to *Puccinia*. Only pycnids and teleutospores have been found. The division of the spores and the production of sterigmas resemble the processes in *Chrysopsora*. *T. Tournefortiæ* on two species of *Tournefortia*.

Disease of the Olive.*—M. G. Boyer gives a careful description of *Cycloconium oleaginum*, a fungus which has as yet been observed only on the olive. It grows on both sides of the leaf and on the peduncle, but is rare on the olives themselves. If the yellow spots on the upper surface of the leaf are microscopically examined, they will be found to consist of three concentric regions, an external region occupied by the peripheral extremities of the mycelle, a middle region where spores are developed, and an internal region which is occupied by spores more completely formed. The spores are yellowish-green, with a single or sometimes two transverse septa.

Coleosporium Pini sp. n.†—Mr. B. T. Galloway finds this new parasitic fungus on leaves of *Pinus inops*. Only teleutospores have been observed, which are two- to four-celled. It was always found in conjunction with *Peridermium cerebrum*, with which it has possibly a genetic connection.

Penetration of the violet Rhizoctone into the Beetroot and Lucerne.‡—M. E. Prillieux states that a great number of cultivated plants, particularly saffron and lucerne, are killed by a fungus to which De Candolle has given the name of rhizoctone. It forms a network of filaments, at first whitish, then violet, in the middle of which are found a quantity of small hemispherical bodies of a deep colour, and the nature of which is but imperfectly known. The author describes carefully the structure of the rhizoctone in the beetroot and in lucerne; in the latter case we have the same structure as in the former, but on a somewhat larger scale. The filaments of the mycelle also, under certain conditions, penetrate the living tissues of the host.

Fungus-parasites on Animals.§—Prof. R. Blanchard gives an account of the following parasitic fungi which are transmissible from the lower animals to man, and *vice versa*, including their structure and development, and their pathogenic effects:—*Trichophyton depilans* Még., *T. tousurans* Malm., *Actinomyces bovis* Harz., *Microsporion Audouini* Grub.

Micromyces Hoffmanni.||—Prof. M. Gruber demonstrated a micro-organism closely resembling *Actinomyces* in its morphological characters. The fungus is made of delicate branching hyphæ with thickened occasionally calcareous ends. When grown on sugar it produces acetic acid. Its pathogenic action differs from that of *Actinomyces* in producing a local abscess which opens spontaneously. Rabbits are specially subject to its influence.

* Journ. de Bot. (Morot), v. (1891) pp. 434-9 (1 pl.).

† Journ. of Mycol., vii. (1891) p. 44. See Bot. Centralbl., xlviii. (1891) p. 296.

‡ Comptes Rendus, cxlii. (1891) pp. 1072-4.

§ Journ. de Micrographie, xv. (1891) pp. 313-7.

|| International Congress of Hygiene and Demography. See Lancet, ii. (1891) p. 377.

Cultivation of Basidiomycetes.*—M. J. Costantiu describes the mode in which he has been successful in obtaining pure cultures of several species of Basidiomycetes. For *Nyctalis lycoperdoides* he uses the chlamydospores, for *Marasmius Oleæ* the basidiospores, and the perpetuity of the cultures was obtained by means of the mycelle.

Saccharine Matters in Boletus edulis.†—M. E. Bourquelot gives the proportions of saccharine matters found in one kilogram of fresh tissue of *Boletus edulis*. In the stipe 24.5 grm. of trehalose and 0.77 grm. of glucose; in the pileus 13.8 grm. of trehalose and 0.71 grm. of glucose. In the hymenophore (tubes) no saccharine matters were found. This explains why the larvæ of diptera are almost exclusively localized in the stipe of the fungus.

Protophyta.

a. Schizophyceæ.

Movements of Diatoms.‡—From observations made chiefly on *Synedra*, Herr K. Schilberszky confirms Pützer's theory as to the cause of motion in diatoms. With the aid of very finely divided coloured particles, it is easy to demonstrate the existence of currents on the surface of the diatom-valve, which are usually interrupted jerking or pulsating movements, though the particles are sometimes driven rapidly without interruption from one end of the diatom to the other. The seat of this motion is, in the author's view, a coating of protoplasm which escapes from the interior of the diatom outside the raphe, and also between the overlapping edges of the two valves, on the girdle-side; whether it also protrudes through pores in the valves he is unable at present to say. The fine particles of protoplasm which thus protrude are probably in a condition of vibratile motion, though this motion is exceedingly difficult to make out, in consequence of the extreme tenuity of the threads and their very rapid movement.

De Toni's Sylloge Algarum (Bacillariææ).—The second section of vol. ii. of De Toni's *Sylloge* is devoted to the division of diatoms known as Pseudoraphideæ, and comprises the following families:—Nitzschiaceæ, Cylandrothecaceæ, Surirellaceæ, Diatomaceæ, Meridionaceæ, Trachyspheniaceæ, Fragilariaceæ, Plagiogrammaeæ, Liemophoraceæ, Striatellaceæ, Ertopylaceæ, and Eunotiaceæ. Descriptions are given of 1287 species, of which 187 belong to *Nitzschia*, 194 to *Suriraya* (*Surirella*), 112 to *Campylodiscus*, 86 to *Synedra*, 92 to *Fragilaria*, 64 to *Rhaphoneis*, 48 to *Plagiogramma*, and 97 to *Eunotia*.

Campylodiscus.§—Mr. J. Deby publishes a monograph of this order of diatoms, illustrated by 15 beautiful phototypic plates. Abolishing no less than 197 names of previous authors, he reduces the number of species to 80, of which 23 are new, and 11 British. All the species, except one or two, are marine or brackish.

A frustule of *Campylodiscus* is formed by two saddle-shaped valves,

* Rev. Gén. de Bot. (Bonnier), iii. (1891) pp. 497-511 (1 pl.).

† Comptes Rendus, cxiii. (1891) pp. 749-51. Cf. this Journal, 1891, p. 504.

‡ Hedwigia, xxx. (1891) pp. 273-90 (1 pl.).

§ 'Analysis of the diatomaceous genus *Campylodiscus*,' London, 1891, 98 pp. and 15 pls.

these saddles being thrown across one another with their concave sides facing but not touching each other, so as to leave space for the soft living contents of the diatom. The connective zones, as in other diatoms, telescope one over the other, and unite the two valves by their outer margins. Having to follow the curvatures of two valves bent in opposite directions, they thereby acquire a remarkable zig-zag or undulating appearance, which at first sight is often somewhat difficult of interpretation, especially when complicated with the reduplication of the cells. All the other characteristics of the genus are those of the family Surirellæ, to which it clearly belongs.

Mr. Deby gives the following definitions of terms:—*Marginal rays* or simply *rays* are the radiating lines (called by others "costæ" or "canaliculi"), which, starting from the outer margin of the valves, converge towards the interior of the disc. These rays may be *simple*, which is the commonest occurrence, or they may be *moniliform*, constituted by beads either in single or double rows, or they may be *imfundibuliform*, having the outline of a funnel with its lengthened outlet. The upper broad portion he calls the *funnel*, the slender part the *stem*. The central portion of the valve inside the internal termination of the rays is the *area*; it may be smooth and hyaline, or it may be *striate* or distinctly *punctate* or dotted, the dots forming regular lines or else being irregularly scattered. In one division of the genus the area becomes reduced to a central median linear blank space, or to a simple elongated line. This is called the "raphe" or "pseudo-raphe"; it shows neither the central nor the terminal nodules of the *Naviculæ* proper. All lines, bars, or smooth striæ on the area, the author calls the *striæ*, in contradistinction to the "rays" which have their origin at the margin of the valves, and which terminate before the areal striæ make their appearance. In some cases the area is surrounded by a concentric row of approximating beads or dots or of abbreviated lines; these collectively constitute the *circlet*.

New Genus of Fossil Diatoms.*—Under the name *Bergonia*, M. J. Tempère describes a new genus of fossil diatoms from Barbadoes allied to *Asterolampra* and *Rylandsia*, but distinguished by its general aspect, and by the presence in its median region of two small oblong "oculi."

β. Schizomycetes.

Structure of Bacteria.†—Prof. E. Zettnow corroborates the views of Klebs and Bütschli on the structure of bacteria. These authors regard the individual bacterium in the light of a cell, the chromatic portion, viz. that which is usually seen after staining with the ordinary pigments, being the nucleus and the sheath and its prolongations only seen with difficulty or after special preparation, as the plasma. The latter is usually extremely delicate, and its achromatism requires to be neutralized by means of mordants, and even then is not rendered evident with the same distinctness as the plasma. The illustrations given by the author are however clear enough, and these were obtained by photographing the preparations made by Loeffler's method. The micro-

* Le Diatomiste, i. (1891) p. 70 (2 figs.).

† Centralbl. f. Bakteriöl. u. Parasitenk., x. (1891) pp. 689-94 (1 pl.).

organisms shown in the illustrations are specimens of *Spirillum serpens*, *Proteus vulgaris*, *Chromatium Okeni*, and the corkscrew bacillus, in all of which the plasma and the nucleus are well seen.

For photographing the preparations, the large Zeiss photomicrographic apparatus, crythrosin plates, chrom-copper filter, an apochromatic lens of 2 mm. focus, and projection ocular iv. were used. The sunlight was not thrown directly on the condenser, but through a lens of 1 m. focus.

Protopopoff* describes a bacterium which, when treated with dilute fuchsin solution, became unequally stained, the pale rose-coloured body being traversed by bands of dark-red hue, which run in obliquely. Cultivated on different media, this bacterium was found to show dark bands or granules, and a similar formation of granules had been previously observed by the author in *Actinomyces*.

The author considers the phenomenon to be due to the irregular accumulation of the chromatin. Similar appearances described by other authors have received different explanations, Ernst regarding them as resulting from a kind of nuclear division, and A. Fischer explaining them as being due to the physical action of the environment.

Morphology of the Bacterial Cell.†—In a lecture delivered at the opening of the course of experimental pathology at the Faculté de Médecine, Prof. J. Straus, after discussing the various morphological characters of bacteria, points out that the combined efforts of most histologists have tended to make the structure of the bacterial cell harmonize with that of ordinary cells. The author then discusses the views of Altmann, who stands opposed to the usual current opinion. To most the cell is the morphological unit, an element which can be no further subdivided, but a unit which may be, anatomically and physiologically, simple and homogeneous or complex and intricate. To Altmann the cells are not elementary organisms, but colonies of organisms grouped according to certain rules of colonization, the morphological units being the elementary granules observed in the protoplasm and nucleus of the cell, which are compared to bacteria from their resemblance in form, in histo-chemical reactions, in movements, and in metabolism.

The author regards this idea as being rather risky, and points out that it is very much the same as the doctrine of Béchamp, and also that quite similar views were enunciated by H. Martin.

Nuclei and Division of Bacteria.‡—Herr Nils Sjöbring, in a commendably curt and concise communication, relates the results of experiments for ascertaining the structure of bacteria. The organisms dealt with were *Bacillus anthracis*, a hay bacillus, a vibrio, and several kinds of cocci. Most of the known fixation and staining methods were employed; but the most satisfactory procedure was to fix with nitric acid, alone or with alcohol, without previous drying, staining with carbol-methylen blue or carbol-magenta red, decolorizing with nitric acid, and examining in glycerin or water.

* Annal. de l'Inst. Pasteur, 1891, p. 332. See Centralbl. f. Bakteriolog. u. Parasitenk., x. (1891) pp. 702-3.

† Journ. de Micrographie, xv. (1891) pp. 175-83, 238-47.

‡ Centralbl. f. Bakteriolog. u. Parasitenk., xi. (1892) pp. 65-8 (1 pl.).

By this method two kinds of corpuscles, differing as to position and in staining reactions, are demonstrable within the bacterial cell. The one lie just inside the cell-wall, and stain deeply with the phenol-fuchsin solution. The other lie in the position analogous to the nucleus of the higher vegetable cells, and present appearances depicted in the illustrations given by the author, quite on all fours with an ordinary nucleus, both in the resting condition and in that of indirect division.

The bacterial nucleus is chromoleptic for the blue solution. Unstained these portions of the nucleus resemble vacuoles. The extra-nuclear part of the cell never picked up the blue dye; no structure was detected in it; it had a yellowish reflex, and was pretty strongly refracting. No double staining was ever attained.

Observations on the vibrios were more difficult, but they appear to have analogous relations, though in some the nucleus is located at one end, a condition induced by the swelling of the plasma.

In micrococci the results obtained were much the same, the fission phenomena being clearly visible in picro-acetic acid, phenol-methylen-blue, and cosin preparations.

The author's communication is accompanied by ten coloured illustrations representing *Bacillus anthracis*, hay bacillus, and fowl cholera, as seen under 1/18 apochromatic and with ocular iv.

Nucleus in Bacteria.*—Prof. J. Frenzel reviews the opinions on the question whether the Schizomycetes contain a true cell-nucleus, of Zopf, De Bary, Bütschli, and others; and states his own view, drawn from observation of a green bacillus of very large size found in the intestinal canal of an *Aneura*-larva in Argentina. Many of these bacilli contained either a single central strongly refringent body, or one towards each pole, which at first presents the staining reactions of a nucleus, but afterwards rather those of a cell. The general conclusion of the author is that the so-called spores of bacteria consist of substances which cannot be regarded as caryoplasm. They must rather be considered non-nucleated cells, since they have taken up into themselves a constituent of the cell without its transformation into caryoplasm.

Nuclear Structure in Bacteria.†—Mr. H. Wager describes a structure observed in a bacillus which formed a thin scum on the surface of water containing *Spirogyra* in a state of decay. In the centre of each cell was found a substance deeply stained by fuchsin. In young cells it consists of two rods, deeply stained, placed side by side, with a less stained substance between them, the whole being surrounded by a very thin membrane which is visible only at the two ends. These two nuclear rods ultimately divide completely to form two groups containing two rods each; and the division of the cell-wall keeps pace with that of the central mass; the two halves becoming ultimately separated and forming two new cells.

Phagocytosis.‡—Prof. A. Capparelli recounts some important and interesting experiments which throw new light on the doctrine of phagocytosis. He injected into the dorsal lymphatic sac of a frog,

* Biol. Centralbl., xi. (1891) pp. 757-63.

† Ann. of Bot., v. (1891) pp. 513-4.

‡ Centralbl. f. Bakteriologie u. Parasitenk., x. (1891) pp. 277-80.

spores of *Ustilago carbo* suspended in water. In course of a few hours the spores were consumed by the phagocytes and taken into the circulating blood. Though relatively large, 2-3 spores may be seen in the microphages and 8-10 in the macrophages. For some days there is no obvious change in the swallowed cells but later they become yellowish, their protoplasm granular, and are eventually resolved into a collection of minute granules inclosed within the phagocyte which has also undergone analogous changes.

Immediately after the injection the activity of the phagocyte seems to increase, a period succeeded by a diminution of the phagocytes in the circulating blood; if the frog be now killed free spores are found in the viscera, being most numerous in the liver and spleen, and especially in the former. In fact, wherever the spores are injected they invariably accumulate in these organs.

The fate of the phagocyte goes hand in hand with the destruction of the spore.

Observations on the liver showed that the included spores become, so to speak, digested by the phagocytes which at the same time become granular and swell up, and the reliets of the two bodies may be observed occasionally in the blood, but more frequently in the bile.

After showing that the spores do not contain or produce any toxic substance which might react on the phagocyte, the author alludes to the different hues the spores assume in the liver, spleen, and abdominal glands, being yellow in the first, yellowish-brown in the second, and orange in the third.

Connecting this with the fact that the destructive action of the phagocyte while circulating in the blood-current is but slight, the author suggests that the process is possibly in a great measure due to the action of the fluids of these organs.

Ætiology, Pathogenesis, and Treatment of Tetanus.*—The tetanus bacilli, says Sig. Sormani, exist in the uppermost layers of the ground, and especially where this has been recently manured or infected in any way. By rolling on the ground and afterwards licking their dirty hides dogs and other animals introduce the bacilli into their alimentary canal and then afterwards deposit them again with the fæces.

From this arises the curious phenomenon that the virulence of the bacteria first becomes attenuated by the gastric juice, and afterwards, in the intestine, reassumes its potency. If animals be withheld from any exposure to fresh infection their fæces will still remain virulent and tetanous, thus rabbits have been infected from the fæces of dogs which have been confined for at least sixteen days. Tetanus bacilli invading the organism by the respiratory tract do not infect unless they are able to penetrate within the tissues. Most cases of this disease have been acquired by wounds becoming infected by dunged earth. As tetanus bacilli are extremely resistant to the ordinary disinfection solutions and are only destroyed with anything like rapidity by iodoform and acidulated 2 per cent. sublimate solution, the obvious treatment is to scrape the wound and then having washed it with the sublimate solution to sprinkle it with iodoform.

* Trans. Internat. Med. Congress, 1891. See Bot. Centralbl., xlvii. (1891)p. 330.

Streptococcus pyogenes.*—Prof. E. M. Crookshank describes a micro-organism which he has found in acute cases of suppuration, and which appears to possess great resemblance to that found by Klein in scarlet fever and diphtheria. The identity of *St. pyogenes* with *St. erysipelatosus* is discussed, and the author inclines to the belief that though similar in many respects, they are not the same.

Bacillus capsulatus mucosus, a new Capsule Bacillus.†—Dr. M. Fasching describes a capsule bacillus which he obtained from the nasal secretion of two cases of severe influenza. The bacilli are 3–4 μ long and about 3/4–1 μ thick. They are enveloped in a capsule which may inclose one to four individuals. Sections stained with phenol-methylen-blue showed that the microphytes were strictly confined to the blood vessels, from which it followed that the affection was a true septicæmia, though in one case the inoculation was followed by suppuration of one extremity (mouse). In the pus examined great variations of shape were observed in the micro-organisms, and as Gram's method failed to demonstrate the presence of ordinary pyogenic microbes, and as from the pus were recultivated the typical bacillus possessing its proper physiological functions, it seemed probable that the suppuration was due to some aberration on the part of the micro-organism or its environment. The bacillus was pathogenic to white and field mice, which died in two or three days after inoculation; pigeons and rabbits were quite refractory to the virus and the experiments on guinea-pigs were inconclusive.

The microbe was isolated on plates which contained 10 per cent. gelatin and 1 per cent. grape-sugar. Circular milky non-liquefying colonies developed. Their upper surface was cupped, and they exhaled a faint aromatic odour. To the naked eye their appearance resembled so many drops of mucus about the size of pins' heads. Puncture cultivations soon assumed the nail-like appearance, and there was a formation of gas. From stroke cultivations a mucoid deposit was obtained. This was insoluble in water; swelled up on heating, imparting an opalescence to the fluid; was precipitated by alcohol and acetic acid; was redissolved by strong mineral acids and by alkalies; in fact, gave the same reactions as mucus. The gelatin was never stained or discoloured. Cultivations were also made in 1 per cent. agar on potato, on meat-pepton-grape-sugar-gelatin stained with litmus, and with Petruschky's litmus-medium. From the latter the fact was determined that at first a small quantity of acid was formed, though afterwards alkali.

The organism was also cultivated anaerobically. It was easily stained by aqueous solutions of anilin dyes, but was decoloured by Gram's method. No movements were observed in hanging drops. It does not form spores. It grows extremely well from 18°–35° C. It was found to be extremely pathogenic to mice, which usually succumbed in 36–48 hours. All the animals suffered from conjunctivitis, and the post-mortem appearances were those of fever.

The author, in conclusion, notes that there are other capsule bacteria, some of which closely resemble *B. capsulatus mucosus*; these are

* Centralbl. f. Bakteriöl. u. Parasitenk., x. (1891) p. 648.

† SB. K. Akad. Wiss. Wien, c. (1891) pp. 295–309.

Microc. tetragenus, *B. pneumoniæ* Friedländer, *B. pseudopneumonicus* Passet, *B. capsulatus* Pfeiffer.

Bacillus rubellus.* — Dr. K. Okada gives details of a micro-organism, which, like the pathogenic bacillus noticed in this Journal, 1891, p. 513, was obtained from floor-dust. The distinguishing feature of this bacillus is that it produces a reddish pigment, whence its name *B. rubellus*.

Morphologically it resembles somewhat the bacillus of malignant œdema. Its ends are slightly rounded; usually two or three rodlets are united and sometimes filaments 10–15 μ are formed.

Very active movements were observed in hanging drop cultivations, and the flagella were demonstrated by Loeffler's method at one or both poles. The spores, which are endogenous, resist considerably heat and chemical agents. The bacillus is stainable with the ordinary anilin dyes and also by Gram's method. This chromogenic bacillus is itself colourless and is non-pathogenic. It was cultivated on the usual media (gelatin-agar-bouillon) but only grew in the absence of oxygen. The appearances of gelatin and agar tube cultivations are depicted in coloured illustrations.

Anaerobic Bacillus of Panic Fermentation.† — Herr M. Popoff describes an anaerobic bacillus in cultures from dough made in vacuum or in air destitute of oxygen. It has the form of short rods with rounded ends, does not form spores, and resembles Peters's bacillus A; it can also live aerobically. It produces lactic acid, and causes the ordinary phenomena of panic fermentation in dough.

Potato Disease and its Cause.‡ — Herr E. Kramer has, by the aid of bacteriology, attempted to ascertain the cause of potato blight. Previous observers had assigned the disease to the anaerobic organism *Bacillus amylobacter* (*Clostridium butyricum* Prazm.), but the author finds that an aerobic bacterium, which liquefies gelatin with great rapidity, is the cause. The bacillus of potato rot is a rodlet 2.5 to 4 μ long and 0.7 to 0.8 μ broad, having rounded ends and exhibiting lively movements. In old cultivations endogenous spore-formation is observed.

The bacillus presented on agar and gelatin characteristic appearances, the latter being liquefied, and if stained with carminic acid or litmus the colour was discharged. In solution of dextrose to which ammonia or pepton and the necessary salts were added, the bacillus developed very strongly, giving off carbonic and butyric acids.

From pure cultivations of the bacillus bred in potato mash extract to which 1 to 2 per cent. dextrose was added, inoculation experiments on sound tubers were made, and the results were quite satisfactory, showing that this organism is the only cause of the disease of the potato tuber. The mode of entrance of the bacillus into the tuber is supposed to be the result of accidental damage, or at the eyes.

The chemical changes which the bacillus sets up in the blighted

* Centralbl. f. Bakteriöl. u. Parasitenk., xi. (1892) pp. 1–4 (1 pl.).

† Annal. de l'Inst. Pasteur, 1890, pp. 674–6. See Bot. Centralbl., xlix. (1892) p. 43.

‡ Oesterreich. Landwirthsch. Centralbl., i. (1891) pp. 11–26. See Bot. Centralbl., xlviii. (1891) pp. 58–60.

tuber are first characterized by an acid reaction, the result of the formation of carbonic and butyric acids, and afterwards by the alkaline reaction, due to the decomposition of albuminoid matters and the production of ammonia, methylamin, trimethylamin, &c. These bases neutralize the butyric acid, and when in excess they mark the second period of chemical change. The general character of these fermentations excited the suspicion that the bacillus might not be identical with the *Bacillus butyricus* Hueppe. This doubt was set at rest by inoculating sterilized milk, but the only change set up was the coagulation of the casein.

Experimental Angiocholitis.*—MM. Charrin and Roger succeeded by injecting bouillon cultivations of *Bact. coli commune* in exciting suppurative inflammation in the bile-ducts of rabbits. The results were different according as cultivations virulent or attenuated by saprophytic growth were injected. In the former case the animals died in 2–3 days; in the latter they remained alive, and were killed at various periods. In rabbits killed after eight days the gall-bladder was filled with pus, and the liver bestudded with miliary abscesses. Microscopically a pronounced pericholangitis was observed. In animals treated with virulent cultures, besides the inflammation about bile-ducts, small abscesses in the hepatic lobules were found. Suppurative inflammation of the bile-ducts may therefore be excited by *Bact. coli commune*, and its behaviour in the liver is not so harmless as in the intestine.

Claim of priority on a point in connection with the Immunity question.†—Prof. Ogata now claims that he was before Behring and Kitasato in indicating that the toxins of diphtheria and tetanus are destroyed by cell-free blood. Indication, however, is hardly explanation, and it would seem that the author's claim is limited to indicating that what was true for anthrax might be true for other diseases and for other animals.

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MICROSCOPY.

a. Instruments, Accessories, &c.*

(2) Eye-pieces and Objectives.

Microscope Objectives.†—Prof. T. J. Burrill read before the American Society of Microscopists the following paper:—"I had the honour of presenting to this Society, at its last meeting, a paper embodying my experience and opinions concerning the Microscope. I now wish to offer the result of personal experience in the use of various objectives for microscopical work, especially along the lines followed as a teacher and investigator of biological science. The task thus set before me is more difficult than that of last year. Little niceties of difference count much more in an objective than in the construction of stage, or rack-and-pinion adjustment; and though one may be sure that his preference is not founded upon fancy, yet he may find it hard to state in words upon just what special characteristics he bases his choice. In the paper of last year the names of makers are carefully excluded; this time it is impossible to get along without reference by name to the manufacturers of the instruments cited. I heartily wish it could be avoided and accomplish the purpose intended, for it is a source of embarrassment to myself, and is also liable to be seriously misinterpreted. All that can be said in justification of what follows, is that I am under obligations to no one, either directly or by implication, except as necessitated by truth and fair dealing, and that matters of personal interest are thoroughly placed aside, if I am capable of so doing. The articles used are all owned by myself, or by the institution in whose service I am, with one somewhat conspicuous exception, and that was loaned to me, upon request, for the purposes of this paper. No comparison is made with such as I have not had abundant opportunity to test, and, with the exception just mentioned, with none that have not been in use during some years of time. In the paper upon Stands, a note was made upon the fact that we are prone to like best that with which we become acquainted. In the case of objectives, however, there is less room for such preference, because the mere handling of one is practically that of others, including the position and movements of one's body when at work. To be sure, in order to get the very best results with a high quality objective, one must patiently learn to use that particular instrument; but this is another thing. The force of habit has little to do in this last case, while it is exceedingly strong in the method of moving the object under the lens, and in the manipulations generally of the stand.

It should also be stated that my work has chiefly been upon uncoloured objects mounted in water, with or without the addition of carbolic acid or glycerin, and upon coloured objects in balsam; the main exception is that of diatoms in balsam, and in this case as a test for the objective rather than work upon the objects for their own sake.

* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous. † Microscope, xi. (1891) pp. 321-8.

Magnification.—Whatever may be the facts in regard to the use of high-power eye-pieces to secure the requisite magnification in mere tests, for long-continued work over the tube anything in the upper end of less than about one inch focal length is unsatisfactory to me. The strain upon the eye is certainly less with the medium and low-power oculars, and the image is better to my eye, even with the finest objectives made. I chose, therefore, such focal length in the objective as will give sufficient magnification with a Huyghenian eye piece, amplifying about ten times as the upper limit. Higher magnification by the eye-piece may be useful in testing an objective, and may, it is true, to some persons, be available for long-continued work; but I am making a report of personal experience. The only other thing necessary to say here is that usually the less amplification the better, after a suitable amount is obtained. Hence neither objective nor eye-piece should be of less focal length than will conveniently serve the purpose required. For a botanical laboratory a $1\frac{1}{2}$ in. and a $1\frac{1}{5}$ in. dry objective are the best selection for the common work of students. Occasionally higher powers are needed, sometimes running up to the highest and best procurable. For these exceptional cases provision should be made by having a few objectives at hand, but students need not be furnished with them as with those first named. Really serviceable magnification seems to reach its limit in about a $1\frac{1}{15}$ in. or at most a $1\frac{1}{18}$ in. objective. Only in rare cases is anything of higher power than a $1\frac{1}{10}$ in. of best quality effectively superseded—with me, in nothing but certain studies upon bacteria.

Angle of Aperture.—It appears to me that something similar can be said of the angle of aperture. In the matter of difficult resolution with oblique light, high class and even medium grade objectives have been, in my hands, proportionally successful in just about the order of their aperture, though exceptions have been noted. But for most other uses, it does not appear that the angle of aperture should be relatively rated so high, in the qualities of objectives. It must not be inferred from this that wide angles are, in and of themselves, injurious for biological work. Other things being equal, I should always prefer them, cheerfully putting up with any lack of penetration, and, to a certain extent with inconvenient working distance, for the other advantages offered; but crispness of outline, of even the smallest bacteria, depends upon something else quite as much as upon the aperture and cost price of an objective. These smallest bacteria measure about $1\frac{1}{50,000}$ in., or about the distance apart of the dots from centre to centre of *Pleurosigma angulatum*. We all know that great angle is not necessary upon objects of this size. The question is whether excess of angle above a certain essential degree is of any importance whatever, or indeed, whether an objective of wide aperture is, on this account, especially superior, when the illumination is a narrow beam of axial light. When the object is too small or too slender to be seen by a narrower angle, no doubt can exist even in this case of the essential advantage of the greater aperture, but unless one wishes to see the flagellum of a bacillus, or a minute structure of a diatom valve, his laboratory work may, perhaps, be just as successful with first-class objectives, of less than the widest angle procurable. Should these of moderate angle possess better definition (not

resolution), then for their proper work they are better lenses. My later purchases, for students' ordinary use, have been of 110° air angle for $1/5$ in., with the expectation that anything up to the widest numerical aperture may sometimes be accessible. For the closest possible studies upon the exact size (measurement) and shape of small stained bacteria, a Tolles' $1/15$ in. homogeneous immersion of 123° balsam angle is the best I have used, though others at hand have considerably wider aperture.

Get the best.—Having decided what is most suitable for the work proposed, the very best should be selected for students' use, as well as for special investigators. It may be said that the expense would often be too great, and that cheap instruments or none constitute the alternative. Often, however, this is the mere outgrowth of too cheap ideas, either on the part of the instructors or boards of trustees. If the real needs are fairly appreciated, in this as in any other case, they can usually be met in some way. Otherwise, how are Microscopes obtained at all? At any rate, instructors should inform themselves with the utmost care and then equip their pupils in the best possible manner with this, the most delicate of all tools. No questions of home or foreign manufacture, of accidents of popular approval or of hereditary service, should be allowed weight in the selection of a Microscope objective. Neither should the cost price be taken as an index of quality. No one can be blamed for buying what he finds to be the best goods for the least money.

Governed by these principles, I have ceased ordering from abroad, for students' use. Without naming other makers, I choose the objectives of the Bausch and Lomb Optical Company, in preference to those of Leitz. I have in daily use some first-class wide-angle dry objectives of the Gundlach Optical Company, that have given most excellent satisfaction. Anxious to have the best, as improvements were announced, I have ordered, from time to time, five first-class objectives, each one supposed at the time to be the very best in the market. This paper may seem less presumptuous with this statement inserted.

Specific Tests.—I am now to report the results of some comparative tests, made with certain named objectives, under described methods of procedure. When the title of this paper was announced I hoped to have photographs taken in different ways for each objective tried, but have found too much time consumed in other directions to permit it. Please allow me to express the conviction, that these proposed photographs would have certainly corroborated the statements herein made.

In order to decide, with certain correctness, of the relative quality of the objectives compared, the tests were purposely made as difficult as circumstances permitted, but under these difficulties each was given the best handling possible for the manipulator. The objectives, all homogeneous immersions, were as follows:—Tolles' $1/15$ [1880] 123° ; Zeiss' apochromatic $1/12$ [1887] N.A. 1.40 ; Herbert Spencer's $1/10$ [1888] balsam angle 130° ; Gundlach's $1/12$ [1890] balsam angle 136° . The last was asked for and loaned to me for trial. An attempt was also made to include a Leitz $1/12$ [1888] N.A. 1.25 , but it was not possible to use it on the same stand, hence not certainly under the same conditions, and not included in this report. I have not been able,

under fairly similar conditions, to make it do what is reported for the others.

The first tests were made upon Möller's balsam-mounted test-plate, with an ordinary small coal-oil lamp, with flat wick $\frac{3}{4}$ in. wide, and common round chimney, on which, however, was placed a tin extension 16 in. long, to improve the combustion and steady the flame. Any one who sits down to a prolonged task of this kind will appreciate the latter, at least, of the improvements thus obtained. The lamp was placed 30 in. from the mirror to the left, with the centre of the flame used edgewise, and mirror of the same height. The mirror-bar was placed at the angle of 51° from axis of the instrument, and the concave side accurately focused by means of the paper label on the test-slide. No substage helps of any kind were used. After adjustment of objective and light as described, an ordinary bull's-eye, same height as flame or mirror, was pushed in and out at will near the lamp, flat surface to the latter. The tube of the instrument could be closed to $6\frac{1}{2}$ in., measured from its lower end to top of draw-tube, and could be elongated to 13 in. The Tolles' and Spencer's objectives have screw collars; these were adjusted for their best effect with tube-length of 10 in., measured from front of objective. For the others the tube was varied to suit. It should be said that the Zeiss objective was ordered for the long tube.

Amphipleura pellucida, on this particular slide, is of medium grade as to difficulty of resolution, but as difficult as any I have seen in Möller's test-slides. No. 19 is probably proportionally easier, often showing by light and adjustments which No. 18 defies. I think this last is unusually difficult, and the same may be said of No. 12, *Grammatophora subtilissima*. The others seem to be fair average shells. As immersion media, somewhat thickened cedar oil, as furnished by Zeiss, and a fluid sent out by the Gundlach Optical Company, were used successfully with all the objectives, with, however, no perceptible difference in result. The work was done in the daytime, with windows behind the operator, uncurtained. There were no windows in front or at the sides.

Under these conditions all four objectives resolved *Amphipleura* so plainly that any tyro could make out the transverse lines, at least, when the bull's-eye aided the illumination. Often the lines appeared the moment the focus was secured, and this could be changed back and forth with almost certainty that they would be evident whenever the proper adjustment was made. I need not say, however, that it always required careful work, and that there were failures as well as triumphs.

The two non-adjustable objectives did best with the shortest tube and negative ocular. With Zeiss's compensating ocular the result was rather more satisfactory with the 10-in. tube-length. There did not appear to be the same difference with the Gundlach in this respect, the Zeiss eyepiece also showing well with the short tube. With the apochromatic at its best, the diatom appeared perfectly flat, with midrib and margins showing distinct and clear, when the lines were in focus—a thing none of the others did, though Spencer's, perhaps, came nearest to it at 8, with 10-in. tube. The whole field, too, of the first named, including the object, was beautifully white. With the Gundlach it seems to me that the lines were as distinct and crisp as with the Zeiss, and could be counted with reliability a few at a time. When these were best shown the rapho

and margins glowed with red, shading to dark, and a little movement of the focus downward was necessary to render the margins most distinct. With a longer tube the lines more evidently stood above the outline. With the Spencer, at its best, I found little changes of illumination, &c., destroyed the resolution to a more marked degree than with the two others just named; and though the lines were beautifully shown, and the outline fair at the same time, it seemed to me that counting would be a much more difficult undertaking. It should be remembered, however, that the magnification was less, and this I could not fairly make up with higher eye-piecing. Under a solid 1/4-in. ocular I was unable to make any distinction in the quality of the lines. With all three objectives they were like parallel ropes, with uneven and woolly outlines.

The Tolles' objective gave the outlines readily enough, but partaking somewhat of the character just described, with the solid ocular. With the magnification reduced to that of the 1/12 by the use of longer eye-pieces the haziness of lines partially disappeared, but in no way seemed so beautifully sharp as in the other cases. In both the Spencer and the Tolles there was a tinge of red in the raphe, in some cases merging into a dark shade, when the lines showed best under manipulation of the screw collar.

Upon the whole, it seems to me, the apochromatic, in this special test was really in the lead, though the distinction had to be carefully drawn. The results on other diatoms on the plate were similar, so far as could be determined, the rating of the objectives remaining the same.

I next tried the mirror in exactly central position, with other things remaining the same, save as the height and position of the lamp and bull's-eye required changing. This was varied, too, during the same test by inserting a narrow-angled 1/5-in. dry objective as a condenser, taking great care that it was in central position. In each case, to be further assured that the illumination was axial, examination was made by removing the ocular and looking at the bright spot in the back lens of the objective. The difference in the performance of the objectives was certainly less marked than with oblique light. The required tube-lengths remained about as before stated, with, however, less noticeable difference in a given amount of change. I obtained a kind of a glimmer of resolution on No. 19 with the apochromatic and Gundlach's lenses, but nothing with any of them on 18 or 20. The others were well resolved by all four objectives, *Grammatophora subtilissima* giving the most trouble. I have never seen a balsam-mounted *Amphipleura* resolved by truly central illumination, though others have reported it with several objectives. When using the condenser named, by moving it only a little to one side, lines could be made out, but no comparative tests of this kind were made.

I had previously tried, with the help of an expert assistant, the three objectives in my possession in photographing violet-stained bacteria with central light, showing a scarcely appreciable difference, but favouring the Zeiss and Spencer over the Tolles, unless the increased difficulties with the higher power proved too much for the skill of the manipulators.

I have now to add a word in regard to the durability of the apochromatic, the want of which has been frequently questioned. After about two years' use it became that this lens was in some way impaired, and

by looking through it from the back with a magnifier a hazy-granular appearance was noticeable, not due to dust on the back lens.

Last March the objective was sent to the makers for examination and repair. It reached me again in July, as good as new, with the statement that the front lens had been slightly decentered, and that the repair had been easily made, and was without charge. I have no other information upon this point, neither do I know what interpretation to place upon the granular appearance noted. There is certainly nothing of the kind visible now."

Fluor-spar Objectives.*—The following letter, communicated to the American Society of Microscopists, will be read with interest.

Prof. T. J. BURRILL,

Buffalo, N.Y., Jan. 27th, 1891.

My dear Sir,—Your favour† of 21st inst. came to hand this morning. Since coming to Buffalo my time has been so fully occupied that I had for a long time forgotten entirely the subject mentioned in your letter. As the time is so limited, and having no knowledge of how much space you had intended to give to the subject in the forthcoming publication of the 'Proceedings of the A.S.M.,' I have thought best to state to you, as briefly as possible, the facts, leaving it to you to arrange them in proper form for publication, with whatever comments you see fit to make.

During the summer of 1860, Dr. Rufus King Brown, who was at that time a resident of Brooklyn, New York, visited my father at Canastota, and during his stay there my father made for him a $1/8$ objective, which was considered by all who saw it to be the best ever made up to that date. Although but a young boy at the time, I was greatly interested in my father's work, and knew pretty well what was going on—hearing a great deal of talk—and remember well Dr. Brown's high praise of the performance of the objective, but of course knew nothing of its construction until some years later. Some years later, after Mr. Tolles had removed his establishment to Boston, Dr. Brown became a resident of that city, and showed the objective to Tolles, who praised its performance very highly.

The angular aperture of the objective was 175° . One of the systems contained fluor-spar, and it is on record in the formula that it was remarkably perfect in its corrections for both figure and colour, with both oblique and central illumination. In the years 1864 and 1865, I made lenses for quite a number of objectives, mostly $1/4$ in., containing at least one lens of fluor-spar, and having apertures from 170° to 176° ; but of course with very short working focus. In all these objectives, as well as in the one made for Dr. Brown, the spar lenses were cemented between others, as owing to its softness and liability to become scratched it was not considered safe to leave it in an exposed position. About the time that immersion lenses came into general favour in this country the use of the spar was abandoned, owing to the difficulty experienced in procuring that which was free from fractures

* Proc. Amer. Soc. Micr., xii. (1891) pp. 248-9.

† This letter was received by me January 31st, 1891, after the preceding pages were in the press. Prof. Burrill informed me by accompanying letter that he had sent a request to Mr. Spencer for information as to the facts about fluor-spar objectives.—[Ed. Proc. A.S.M.]

or seams. When used in the $1/4$ I dreaded making them more than all others in the objectives, often having to throw them away, owing to their having such defects. Shortly after our removal from Canastota to Geneva I made a $1/12$ water im., containing one spar lens; but that is the only one since I was a boy. When Dr. H. J. Detmers, of Columbus, O., visited me at Cleveland (about the time of the meeting of the A.S.M. at Detroit) I showed to him the old book containing the records of all these objectives as kept by my father, and among them the $1/8$ marked R. K. B., also $1/8$ containing a spar lens, which was made as far back as 1851, about the time my father began making objectives of large angle, showing how early in the fight he appreciated the valuable optical qualities of fluor spar in the construction of objectives. The angular aperture of this $1/8$ was not given, but I can readily see that it could not have been less than 160° .

These are, I think, all the facts necessary, but I may have made too much of it. It has been hurriedly written off and is not in proper shape for publication, but you can cull out the facts and arrange them properly for publication in the forthcoming proceedings. I shall esteem it a great favour if you will do so, as I look upon the facts as of value in connection with the history of the Microscope.

I trust you will pardon the use of the pencil, for I have been anxious to send this by the first mail. Please let me know if it reaches you in time.—Very truly yours, H. R. SPENCER.

Fluids for Immersion Lenses.*—Dr. A. C. Stokes remarks:—"Usually the only immersion fluids at the microscopist's command are water, cedar oil, and glycerin made dense by dissolving in it either cadmium sulphate, zinc carbolate (*sic*) or some other salt. With homogeneous-immersion objectives, or those using an immersion medium with a refractive index as nearly as possible that of crown glass, so that the cover, the immersion medium, and the front lens may form one homogeneous combination with these objectives, water of course cannot be used; so that the microscopist must have resinated cedar oil or the glycerin solutions just referred to. But to obtain the best results from these first class homogeneous-immersion objectives it is important that the immersion fluid should have the proper refractive index, that of crown glass being 1.5, of cedar oil 1.515, the glycerin fluids varying in a way that the microscopist has usually no means of finding out. Prof. H. L. Smith has devised a simple and successful little instrument for the measuring of the refractive index of such liquids, but, so far as I know, it is not in the market. The microscopist must therefore rely on the optician, that sometimes by accident plays him false, and so deprives him of the best that his objectives can do. I have recently had an experience with these substances that has taught me, if not wisdom at least caution in blaming my objectives or even my own lack of manipulative skill.

A certain homogeneous-immersion objective, of not large numerical aperture, was said to be able to resolve *Amphipleura pellucida* well and easily. I made the attempt, and failed, after several hours' work with the lens, using all the care and skill that I possessed. The immersion

* Microscope, xi. (1891) pp. 341-4.

fluid used had been prepared and sold by a prominent optician, and I had no thought but that its refractive index was what it should be. Another evening was given to the examination of the lens over the same diatom; failure. A third evening was devoted to the same work, and failure was the reward. I then gave it up, and condemned the objective or my own skill, being disposed towards lack of confidence in the latter. Yet others had said that that objective would resolve that diatom. A fourth evening was given to it with the same result. Then it suddenly seemed stupid not to think to try another immersion fluid. There might be something lacking in this. I had cedar oil from a well-known European optician, and with a drop of it the objective was focused, with the light as oblique and the mirror exactly as before, when the lines on that shell stood out, if not like the pickets on the fence, at least with a sharpness, clearness, and neatness that was as delightful as it was amazing. In the twinkling of an eye the diatom was resolved to perfection, while with the glycerin fluid, failure and discouragement had been the only results. The objective was vindicated, and so was any skill that the observer might, in a moment of self-complacency, imagine to be his. But on the table were two other glycerin fluids, one by a prominent and accomplished optician of this country, the other by a famous American, who is by all odds the equal of any optician in the world. The immersion fluid from the latter refused to have anything to do with those lines; its action being similar to that of the composition first tried. But the objective was not at fault, nor the adjustment.

The other fluid was then tried, and the resolution was in every respect the equal of that made with cedar oil; if anything it was superior. But there was as usual the fly in the ointment. To remove the glycerin from the objective it is necessary to wash it off with water, but in this case, when the water drop was added, I had a moment of anxiety, for the fluid became white and opaque as milk, and I could see white particles falling on the lens front, like little flakes of snow. Investigation proved that the salt dissolved in the glycerin, a solution which makes so perfect an immersion medium, acts chemically on the nickel plating of the objective, and the glycerin seizing the water, allowed the new salt to fall in opaque white particles. The chemical action is so great, that after using the medium for three times, there was deposited on the cover of the test-plate an iridescent film, having an irregularly circular outline, showing where the metal and the fluid had been in contact. Nor is this all, for across the surface of the front lens itself is a streak of the same insoluble iridescent deposit. The optician declines to make known the composition of the fluid, although he might reveal it with confidence, since no microscopist would ever make the medium for his own use after having a little experience with it. Its action on brass is similar to that on nickel, and must forbid its use as an immersion medium, although it is really the equal of the renowned cedar oil. To the latter, useful as it is, valid objections are its tendency to flow too freely, and the trouble needed to clean it from the lens, alcohol being demanded to remove it entirely, whereas with glycerin, a drop of water is enough. Cannot some of our opticians give us a glycerin medium

with the refractive index of the resinated cedar oil, but without the obnoxious quality of the fluid that acts on the objective mounting? For these learned men the problem should be an easy one. The maker of the dangerous glycerin mixture can surely make something as good. I hope he will never make anything quite so bad, although in its optical action it is as nearly perfect as need be wished. Its hunger for metal is the fatal objection to it.

Upon the optical action of the immersion fluid depends the optical action of the homogeneous-immersion objective. If the former is not of the proper index, the microscopist may deceive himself by believing that his objectives are giving him the best possible results; or if they seem to be optically defective he should remember that the fault may be in the fluid supplied by the dealer. The optician should place at the disposal of every microscopist some simple device by which the refractive index of the immersion medium may be ascertained. Zeiss sends out for this purpose a wedge of glass, which, when used as directed, gives the desired information. Prof. H. L. Smith's device is not obtainable, and that of the German optician can be had, I suppose, only by buying one of his homogeneous-immersion objectives. Without some such means, the microscopist can never know whether he is getting the best work from the objective or not, unless he attempt to resolve the proper diatom every time he begins to use a fresh supply of immersion medium, a method that would be time-consuming, and should be unnecessary. While with the improper fluid he may get moderately good results, with a medium with the correct refractive index he will get the best that the objective can give, provided of course the lens be properly manipulated."

(3) Illuminating and other Apparatus.

A new Modification of the Abbe Drawing Apparatus.*—Dr. W. Bernhard deprecates the discredit into which microscopic drawing has fallen, owing to the enormous advances recently made in photomicrography. Without denying the immense practical advantages of photography, he considers that there are many cases in which the objectivity of the photograph is not desirable. In microscopic investigations we often require to know what the observer really saw, not what he could have seen, and it is only a drawing which can give expression to such subjective observations.

The cause of the complaints brought against drawing apparatus on the ground of indistinctness of the image and of the point of the pencil is not due to any defects in the optical parts of the apparatus, but mainly to a want of proper regulation of the light. All drawing apparatus have this in common, that the plane of the image is projected upon the plano of the drawing. With unequal intensities of the light of the two surfaces, it is clear that the more intense will have the effect of making the less indistinct. In order to see clearly at the same time the plane of the drawing and point of the pencil on the one hand, and the Microscope image on the other, the intensity of the light must be made the same for each. This is effected by reducing the intensity of the light either of the image or of the plane of the drawing.

* Zeitschr. f. Wiss. Mikr., viii. (1891) pp. 291-5.

In the Abbe drawing apparatus two smoked glasses are provided for reducing the light of the plane of the drawing, which is usually the more intense. In order to allow of finer gradations in the reduction of the intensity of the light of both image and drawing plane, the author has modified the Abbe apparatus in the following way:—For the two smoked glasses for diminishing the intensity of the light of the drawing plane are substituted two circular diaphragms, each of which contains four smoked glasses of different degrees of darkness. These are hinged on an arm so that each alone or both together can be inserted between the prism and mirror, or rotated to one side at will. The central position for each glass between the prism and mirror is marked by a catch.

For reducing the intensity of the image, a third horizontal rotating diaphragm is placed below the prism; it is of the same size as the other two, and, like them, possesses four apertures, three of which contain smoked glasses, while the fourth gives free passage to the rays out of the Microscope. The three diaphragms together allow of exactly 100 possible combinations.

Winkel's new Drawing Apparatus.*—Dr. H. Henking describes the new drawing apparatus of Winkel. In principle it is not new, since it closely resembles the apparatus described by G. Kohl, as well as that recently brought out by the firm of Zeiss. In all three the image is projected by a mirror inclined at 45° upon the horizontal table on which the Microscope stands. The union of the plane of the object and plane of the image on the retina is effected by Winkel by means of a prism, which carries in the centre of the hypotenuse face a small glass cylinder. This cylinder is cut obliquely where it is attached to the prism, so that it stands vertically and transmits to the eye the rays coming from the Microscope. The hypotenuse face of the prism is silvered. For diminishing the intensity of the light he inserts between prism and mirror a rotating diaphragm having five apertures, three of which contain smoked glasses, while the fourth carries a bluish glass, and the fifth has none. The correct position for each glass between prism and mirror is marked by a catch. The arm which carries the mirror is in two parts, so that the distance of the mirror can be varied by one part sliding in the other. Prism, rotating diaphragm, and mirror are carried on a common arm, which is not in rigid connection with the spring socket by which the apparatus is attached to the Microscope, but is movable about a horizontal pin, so that the arm with prism, &c., can be rotated to one side. Lastly, a special clamping-screw permits of the adjustment of the height of the pin, and with it the prism, &c., so as to suit different eye-pieces.

The Grapho-Prism and its Use.†—Dr. F. Gaertner writes:—"To a practical microscopist who is not also a skilled artist, perhaps nothing is more important among microscopical accessories than the camera lucida, or grapho-prism. This prism is an instrument for sketching objects with the point of a pencil upon a piece of paper laid beside the Microscope. By its use a high degree of accuracy may be attained. Perhaps the simplest and most successful drawing prism is that of Zeiss, which is

* Zeitschr. f. Wiss. Mikr., viii. (1891) pp. 295-7.

† Amer. Mon. Micr. Journ., xii. (1891) pp. 265-7.

followed by that of Nachet, Abbe, and Oberhauser. Nobert's and many others work upon the same principles.

The following is an explanation of the principle of this drawing apparatus:—If the glass plate *gl* (fig. 29) stands at an angle of 45° with the axis of the eye, the rays from the object *o* (which on their part also form an angle of 45° with the glass plate) are reflected, and the picture of the object is seen in a position that also forms a right angle with that of the object. If *m* is the cylinder of the Micro-

FIG. 29.

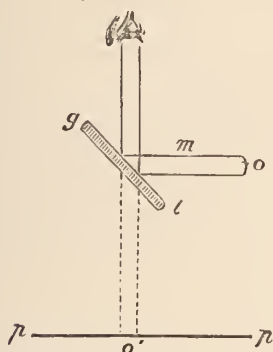
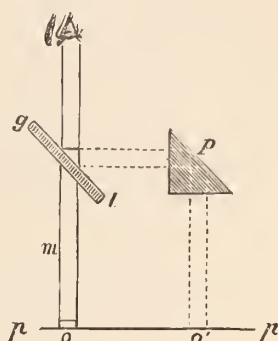


FIG. 30.



scope, and *pp* the piece of paper, in this case the eye will see upon the paper at *o* the picture which is projected by the transparent condition of the glass plate *gl*. In this case we say that the picture is projected; but if we place a prism *p* (fig. 30) upon the same level with the glass plate *gl*, and *o* is the object under the Microscope standing in a vertical position *m*, the glass *gl* forming an angle of 45° with the axis of the eye and standing upright over the ocular, we will then see the picture at *o'* upon *pp*. Meanwhile, the projected picture of the object may also be seen in the horizon. Upon this basis rests the above-mentioned drawing prism, of which Nachet's is the one most commonly in use in Europe after Zeiss's. In this apparatus a prism is employed in place of the glass plate, while a second grapho-prism moves upon its own axis so as to bring the reflecting surfaces at different angles. The purpose of a drawing prism is obvious as soon as it has been placed upon the ocular and adjusted.

Oberhauser's camera is somewhat more complicated than the others. For this reason I will give more in particular the details in regard to its practical application. The ascending rays from the objective are totally reflected through the large prism *d* into the horizontal arm A. If the ocular is placed in a horizontal position B it directs the rays into the small prism C upon the figure of an angle of 45° if focused in the right position, where it is again reflected at a right angle into the observing eye.

Oberhauser's camera is very much liked for this reason: it does not create a disturbance or a confusion by the reflection of the picture at

a right angle upon the projected paper placed in a horizontal position. The Oberhauser camera is attached to the tube of the Microscope at the ocular end, without any trouble or loss of time. With but one exception this camera is perfect; it has a deficiency in one particular. When the microscopic picture is twice reflected it then loses considerably in accuracy, that is, in its clearness and exactness. This is especially so in the use of higher powers, oil-immersions, &c. By the most concentrated light only can the special and superficial contour of the microscopic picture be best produced.

The practical and most applied drawing apparatus in microscopical work is the camera lucida. The object and the paper are seen with the one eye, and at the same time the picture is reflected into the eye by means of the mirror or prism. As the picture is seen upon the paper beside the Microscope, its contour can be reproduced upon the paper with the point of a pencil, and that too with mathematical and scientific exactness; but he who has by practice learned to look into the Microscope with one eye and to hold the other eye open at the same time, may get along even without the use of a camera lucida if he gazes with one eye into the Microscope and with the other eye at a piece of paper lying beside the Microscope. In a few moments the observer will find the object projected upon the paper and will thus be able to sketch the outlines with comparative ease and exactness.

In the execution of the drawing of the microscopic object it is best to use strong paper—Bristol paper or Bristol board—and the paper should be either pale-yellow, pale-green, or white and slightly shaded. It is also advisable to have the paper fastened upon a smooth board. First use a soft and finely sharpened black pencil in order to secure the outlines and the contour of the picture. It should be slightly shaded, without pressure. Then, with bread-crumbs, rub most of it out again. After that, with a heavy pencil, retrace the outlines of the first drawing again, using the prism for comparison and exactness. This moment is the proper time to do the shading, if such is required, and this can easily be done with the point of a pencil and a rubber, or, still better, with charcoal and soft cloth. For drawing a picture with colours, water colours are most commonly used; after them coloured lead pencils, oil colours, and pastel crayon. I wish here to call special attention to this fact, that in shading it is advisable to shade off the uncoloured parts first with black; particular care must be taken that the shading does not extend into the coloured field. It is also decidedly recommended to use a variety of colours, especially in the drawing of very minute objects such as endothelium and epithelium cells, fibrous and connective tissue cells, blood and lymphoid cells. In drawing a whole slide, or only a part of it, it is sometimes desirable to use a variety of colours. Not only will it make a drawing more elaborate, but decidedly more comprehensive and instructive.

Virchow, the most expert pathologist of the nineteenth century, has said that he would not give "ein Pfennig" for illustrations, drawings, or sketches that were not correct and exact, because in every instance it would convey a false impression. Besides this, Virchow has said that all lectures, demonstrations, original articles of any kind, should be accompanied by first-class drawings or illustrations.

I, therefore, would advise every practical and expert microscopist, especially microscopists that are not artists in drawing, sketching, and in the art of producing microscopic illustrations, to make use of the grapho-prism. Especially so would I advise students of practical histology, physiology, pathology, pathological anatomy, bacteriology, embryology, and pharmacology to use the grapho-prism hand in hand with the Microscope."

A new Mechanical Stage.—The following is the text of the remarks made by Mr. H. Bernard when exhibiting his new stage at our meeting on December 16th, 1891:—

The disadvantages of the mechanical stages hitherto in use in the microscopical world are too well known to need mention here. It is enough to say that they fail one exactly when they are most needed, viz. in the systematic study of large objects, such as series of sections, culture-plates, zoophyte-troughs, &c.

The principle of the new stage is such that it is capable of adaptation to almost all the requirements of the microscopist; the mechanism is intended to imitate the movements of the fingers as they shift the object about the stage. A study of the figures* will make my meaning clear.

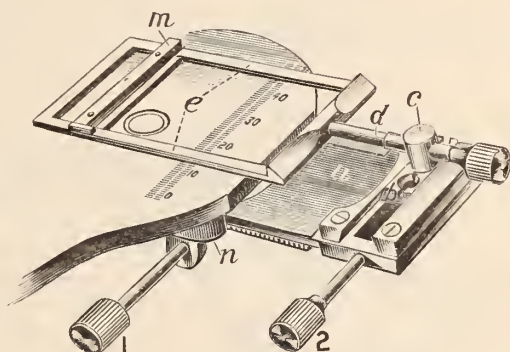
A plate *a* (fig. 31) slides in and out under the fixed stage of the Microscope-stand. A U-shaped piece is cut out of its inner end, so that it in no way interferes with the condenser and substage apparatus. This whole plate is worked by a double rack, one on each side of the plate,

and the pinion 1. The plate is made to slide completely out, but for the mechanical (transverse) movement of slides it has a range of about 7 cm., which is, as far as I know, more than twice the range of any other mechanical table. When driven quite home, *a* projects about $2\frac{1}{2}$ cm. from the side of the stage, so that it is not much in the way, and may be left in its place when the mechanical movement is not required.

The movement to and from the observer is obtained by means of the piece *b* which slides backwards and forwards across the end of *a*. It has a screw movement 2. In the example figured and described *b* has a range of about $3\frac{1}{2}$ cm. But it is clear that this could be largely increased by widening the end of *a*. In the present case, in order to obtain greater range, a device is resorted to which will be described below.

Having thus got a mechanical movement of 7 by $3\frac{1}{2}$ cm. at the sides

FIG. 31.



* The engravings are from photographs kindly taken for me by Mr. C. J. Robinson, of 3, The Broadway, Streatham, S.W.

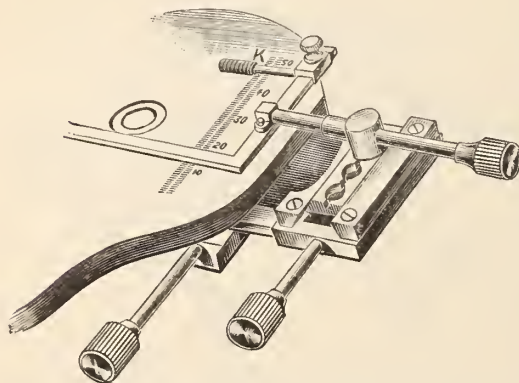
of our Microscope, the question is how to utilize it for the manipulation of slides. Here there is abundant scope for invention and adaptation to the different requirements of the microscopist.

The method here employed of attaching the slides to the piece *b* is by means of a bar, which we call the "arm" *d*. The arm passes through the head of a short stout pin *c*. This pin can be placed in one of three holes in *b*, according to the requirements of the objects to be studied. In order to prevent *c* from rotating in its socket a cross-bar passes through it, and lies in the groove seen in the figure to connect the holes in *b*. The arm *d* thus remains rigidly parallel with the plate *a*, and the movement of the pinions 1 and 2 will clearly carry anything attached to the proximal end of the arm freely across the stage of the Microscope in any direction. In order to give still further range, the arm is made to slide through the head of the pin, and the latter itself can be placed in any one of the three holes in *b*.

There are two methods of enabling the arm to move slides, each of which has its advantages.

If it is especially desired that the slide should lie flat upon the Microscope-stage, then it is perhaps best clipped by an arrangement

FIG. 32.



such as that shown in fig. 32, where the small arm *K* slides up and down, so as to take slides of almost any width ($4\frac{1}{2}$ cm. in the one figured). The tip of *K* is provided with a piece of india-rubber tubing, which prevents slides from escaping when the clip is drawn from left to right.

Another plan is that shown in fig. 31, where the slides rest on a light frame *e*.

The clamp *m* slides backwards and forwards so as to be adaptable to any size of slide, trough, &c.

These clips and frames are clearly the least expensive parts of the whole mechanism, and the microscopist can have several, of the sizes which experience teaches him are most useful for his special requirements.

It is obvious that instead of *d* carrying a frame or clip the end of the arm might be provided with forceps, and in this case the pin might be modified into a ball-and-socket arrangement for the moving of these forceps; we should then have the usual stage-forceps with, however, movements of much greater range.

The new stage as figured here is not made to rotate. There is, however, no mechanical difficulty in the way of making such stages to revolve. In order to attain this the piece *n*, with its corresponding

piece at the other side of *d*, in which *d* slides, would have to be screwed to a revolving ring of the permanent Microscope stage. The revolution could not, however, be complete on account of the projecting part of *a*.

For the recording of the position of objects a scale is cut across the stage, and another along the edge of the frame or long arm of the clip, and the holes in *b* are numbered so that positions at the very opposite ends of even large culture plates could be noted without difficulty.

It remains to be stated that I have tested the stage with high and low powers, with large and small slides, with series of sections, with troughs, and with watch-glasses, and found that it fulfils all reasonable requirements. For watch-glasses a brass plate is either clipped or still better carried on a frame, the Microscope being placed upright. The watch-glass rests in a hole cut out of this plate. A plate of wood or of thick cardboard would of course serve almost as well as one made of brass.

The firm of Carl Zeiss is famous for the excellence of the work it sends out. If the new mechanical stage does not prove to be the boon to microscopists which I anticipate, the fault will lie in the design, and certainly not in the way the designs have been carried out. If, on the other hand, the stage or some modification of it be generally adopted, it will but add one more to the long list of valuable additions to the science of microscopy which have issued from the enterprising firm of Carl Zeiss of Jena.

(4) Photomicrography.

Photomicrography.*—Mr. A. Pringle gives a brief sketch of the various improvements in photomicrography, which have been made within the last two or three years. One of the most important is the improvement in colour-rendering, due to orthochromatic photography. Of no less importance is the remarkable improvement in optical methods which we owe to the so-called Jena glasses. In the production of these glasses it was found possible to obtain different relative proportions of refraction and dispersion, the result of which has been a set of objectives in which the achromatism reaches "an almost ideal point of perfection." The value of these apochromatics is more especially felt in photography, for besides giving better correction these glasses also enable us to obtain a much greater angular aperture, and consequently more perfect definition.

Amongst slight improvements in the ordinary apparatus the author mentions the strong rigid support for the ocular end of the Microscope, which is a feature of the instrument designed by himself and Mr. Swift. This support is very necessary in work with high powers in order to prevent tremors during the exposures.

Having mentioned the more evident improvements in apparatus and methods, the author proceeds to treat of the various difficulties met with in high-class work. The first difficulty considered is that of illumination. For work with high powers it is essential that the substage condenser and the objective should bear some relation to each other in angular aperture and also in focal length. In low-power work the even

* Journ. and Trans. Photographic Society, xvi. (1891) pp. 71-9.
1892.

illumination of the object is best attained by placing, between source and object, the object-glass out of an ordinary low-power eye-piece. For the same purpose the author also invariably uses a bull's-eye.

With regard to illumination by monochromatic light, the author despairs of the method by means of a prism, owing to the uneven illumination of the field. The difficulties of rotundity and colour are next touched upon. The latter may generally be overcome by the help of orthochromatic plates and screens, except in cases where the staining is faint or faded.

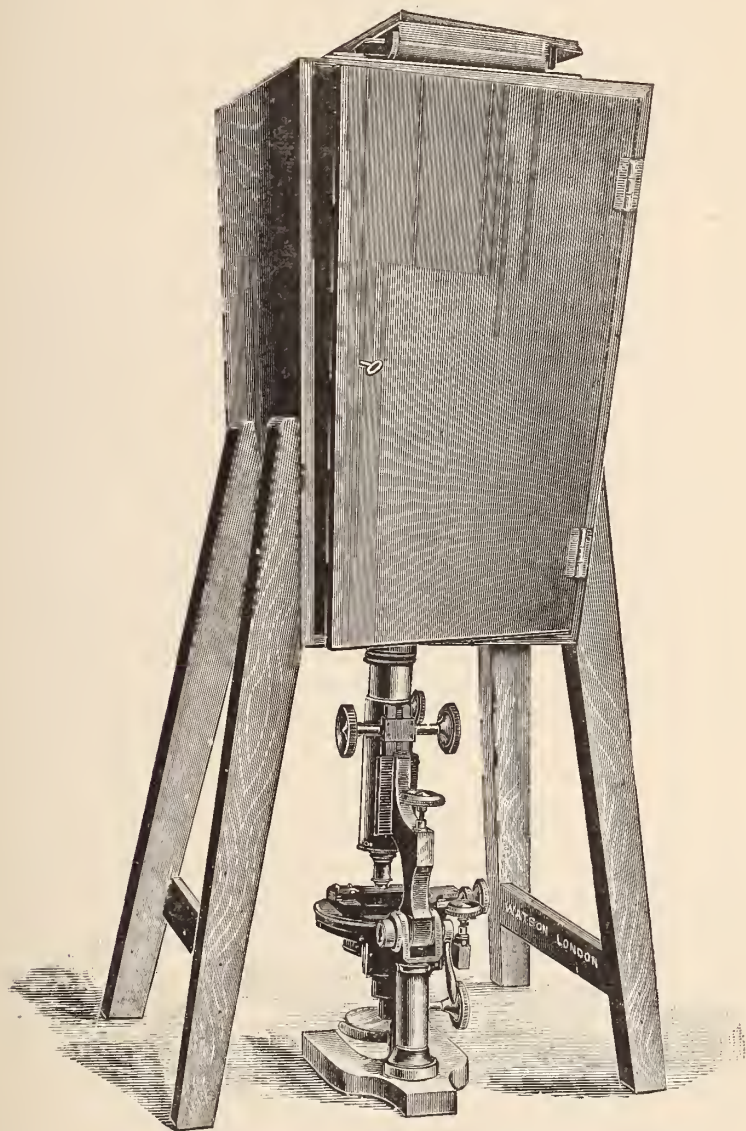
In objects with very fine markings there is generally a tendency to a want of contrast in the result. Such difficulties are very hard to overcome, for, owing to the wide angular aperture required in these cases, the condenser cannot be dispensed with. With regard to increased magnification, the author's experience is that it is a mistake to try to strain a lens to more than ten times its initial power.

Focusing in Photomicrography.—M. P. Francotte communicates the following, which has been translated from his manuscript:—"In photographing a microscopical preparation, two slides, one of ground glass and another of colourless polished glass, are used in order to focus the image. By the first of these slides only a rough focusing can be effected, but it is possible by its aid to appreciate the amount of light on the field of the Microscope and also to judge if the image is equally illuminated in all its parts. The second slide through the intervention of a lens allows of the exact focusing. But here the fact that the image is not visible to the naked eye is a source of great inconvenience; for it is impossible to bring back the object to the centre of the plate if it has been displaced during the operations. The lens which has to be moved about at a certain distance from the image formed on the glass is the only guide.

In place of this slide I have long made use of one of yellow, red, or slightly smoked glass (the last for photographing with sunlight). On a yellow glass the image can be seen by the naked eye, and all its details can be perfectly distinguished without the aid of a lens. Thus an exact focusing can be effected without losing the advantages afforded by the ground glass; for with the naked eye any displacement of the image can be observed, and by means of the lens the exact focusing can be effected just as with the colourless glass. Such are the advantages as regards the focusing of the image. But the tinted glass is of great service when the electric light or sunlight is used. The difficulty in focusing in the latter case is well known; the eyes are dazzled by the excessive light and it is sometimes necessary to forego the advantages presented by the polished glass and lens. This inconvenience is considerably modified by the coloured glass, and the focusing can be effected without trouble (with or without the lens) if the glass is tinted in proportion to the amount of light which falls on the plate. In our opinion all microscopical cameras should possess three slides, one of ground glass, another of glass tinted yellow or red or slightly smoked (like the glasses for moderating the light in the Abbe camera lucida), and lastly a third of colourless glass to be employed in special cases. With the tinted glass the results will be soon found to be far superior and the images much more detailed than before its use."

Van Heurck's Vertical Camera for Photomicrography. — This camera (fig. 33) was exhibited at the February meeting by W. Watson &

FIG. 33.



Sons and is constructed on similar lines to the one employed by Dr. Van Heurck for all his high-power work. It consists of a mahogany body

supported by four legs, with a focusing screen at the top, and at the lower end, a leather bellows, by means of which connection is made between the camera and the Microscope. On one side of the camera body, a large hinged door having rabbeted fittings is placed, and on opening this the head of the worker can enter the camera, and the eye be placed to the tube of the instrument to make the adjustments; the door is then closed and final focusing is done on the screen at the top of the camera. Messrs. Watson state that the advantages are, that all the motions of the Microscope are under the direct control of the hand, and that it can be at once placed over the Microscope, and a photograph taken, without the re-adjustments necessitated by the horizontal form of camera.

(5) Microscopical Optics and Manipulation.

Microscope Tube-length and Resolving Power.* — Mr. H. G. Jameson writes:— “In the discussion of the relative merits of the English and Continental tube-lengths, one argument in favour of the English tube seems to have escaped notice, namely, that it gives, with any individual lens, a distinct advantage in resolving power. Taking the values for the different tube-lengths recently adopted by Prof. Abbe, the gain in resolving power for the English tube with a (true) 4 in. object-glass, is as much as 43 per cent., with a 2 in., 13 per cent., and with a 1 in. 5 per cent. With a 1/4 in. the difference falls to 1 per cent., and with higher powers it becomes imperceptible, but still a gain in definition of 5 per cent. with a 1 in. o.g. is not to be despised.

The advantage of the long tube may easily be observed practically by taking an ordinary optician's 4 in. objective (probably really about a 3 in.), and inserting a diaphragm behind the lens about 1/4 in. diameter, and examining the 1/100 mm. lines on a stage micrometer—it will be found that these are distinctly separable with a 10 in. tube, but vanish when it is shortened to the Continental standard.

This seems at first sight contradictory to Prof. Abbe's formula, which makes the number of lines per inch resolvable by any lens

$$= \frac{2}{\lambda} \text{N.A.}$$

But we have only to examine carefully the definition of

numerical aperture, viz. $\text{N.A.} = n \sin u$, to see that N.A. is itself a variable quantity. The matter may be simplified by leaving out the term n , that is, by considering only non-immersion lenses, in which case $\text{N.A.} = \sin u$. Let R = the semi-diameter of the lens, f = its focal length, and T = the optical tube-length. Then, so long as the lens is focused at its true focal length, and the rays issue parallel beyond it,

$\sin u = \frac{R}{f}$. But in practice, of course, the lens is withdrawn farther from the object, so that the rays converge above to form an image at a distance depending on the tube-length. Call this anterior conjugate focus f' .

Then $f' = \frac{Tf}{T - f}$. And, therefore, in the practical use of the microscope, we get the modified expression, depending upon the value of

* Engl. Mech., liv. (1892) p. 489.

$T, N.A. = \frac{R(T-f)}{Tf}$. It evidently follows from this, that measurement with the apertometer only gives the N.A. for the particular tube-length used in the experiment, and that a lens should not be described as of such and such N.A. without mentioning the length of tube with which it is intended to be used.

Of course the deficiency of resolving power with the Continental tube-length might be made up for by either increasing the diameter or deepening the curves of the lens. But this involves more careful correction and increased expense. So that the argument may be put this way: the short tube, in order to give the same results in the way of resolution as the long, requires to be fitted with a more expensive lens."

Optical Theory of the Microscope. The Virtual Image.*—Senhor D. Joaquin Ma. de Castellarnau in this little treatise deals with the optical theory of the virtual image, a subject which has been somewhat neglected in most books on the Microscope.

The object of an optical instrument is to modify advantageously the retinal image with respect to the limits of visibility. The first section of the book is accordingly devoted to the consideration of these limits. The function of the eye as an optical instrument, the question of accommodation, the magnification of the retinal image, and the influence of diffraction on its formation, are all fully discussed. The conclusions arrived at are that when the eye fails to perceive clearly the form and colour of an object it is for the following causes:—The want of sufficient illumination as regulated by the aperture of the pupil; the smallness of the retinal image; the alteration which the image suffers from the effect of the diffraction resulting from the pupil; the fact that the eye does not receive and utilize in the formation of the image all the diffracted rays resulting from the passage of the light through the small elements of the object.

In the two remaining sections the author shows the effect of the simple and compound Microscope in extending these limits of visibility. In these sections the subjects of the amplifying power and the numerical aperture are fully treated.

(6) Miscellaneous.

Exhibition of Microscopes at Antwerp in 1891.†—This exhibition, which was chiefly due to the initiative of Dr. H. Van Heurck, was opened in the Athénée Royal, in Antwerp, on August 9th, 1891. The greater part of the exhibits was contained in an immense room, along one side of which was arranged a series of old Microscopes, illustrating the history and gradual development of the instrument. Next to this came the fine collections of Dr. H. Van Heurck, the Microscopes of Watson and Sons, Zeiss, Powell and Lealand, and Nachet, the special collection of Prof. Bolsins, and the bacteriological apparatus of Adnet. Down the middle of the room were arranged the Microscopes of Reichert, various phases in the construction of objectives of Zeiss, the

* 'Teoría Optica del Microscopio. La Imagen Virtual,' *Cronica Científica*, Barcelona, 1891, 105 pp. (29 figs.).

† *Ann. de Microgr.*, iv. (1891) pp. 22-30, 69-96, 120-59, 199-219.

large photomicrographic and projection apparatus of the same maker, bacteriological apparatus from Paris, microtomes of Jung, Microscopes of Leitz, and preparations of Tempère and Thum. Against the opposite wall of the room were boxes containing numerous photomicrograms by Dr. Van Heurck, Thévoz, Müller, &c., and lastly, opposite the Paris exhibit came the apparatus from the bacteriological laboratory of Wiesnegg. The two shorter sides of the room were occupied by two large cases containing Microscopes of Hartnack, apparatus of electrical illumination by Trouvé, bacteriological apparatus of Rud. Seibert, microtomes of Erbe, &c. Above these cases, painted in letters of gold, were the names of famous microscopists and celebrated makers.

In an adjoining room were coloured photomicrograms on glass by Lumière, many photomicrograms of various substances used for purposes of adulteration, and a special exhibition by Möller of type-plates of preparations of diatoms.

The number of exhibitors was comparatively small, but the best firms were well represented, and the instruments to be seen were some of the finest that have been made. Bacteriology was the weak spot in the exhibition. The laboratories of the Belgian, German, and English universities sent no contributions, probably in great measure owing to the clashing of the Antwerp Exhibition with the bacteriological exhibition at the Hygienic Congress in London.

The various exhibits may be divided into the following sections:—

- (1) Historical exhibition of microscopy.
- (2) Microscopes and their accessories.
- (3) Instruments and apparatus of bacteriology.
- (4) Micrographic preparations, photomicrograms; and lastly, works on microscopy.

(1) Historical exhibition of Micrography.—Above the cases containing this exhibition was placed a portrait of Zaccharias Janssen bearing an inscription which stated that the compound Microscope was discovered about 1600 by Hans and Zaccharias Janssen. The authentic instrument constructed by the Janssens about 1600 formed one of the most interesting of the objects exhibited. Next to this instrument were four authentic Microscopes of Leeuwenhoek.

Among the compound Microscopes anterior to the 18th century was one with four glasses, of the form of the instruments constructed by Divini. It was mounted on a tripod, and was formed of two tubes fitting into each other, but was not provided with a mirror. Dr. Van Heurck exhibited a Microscope by Marshall (London, 1704), which approached in its arrangements the Microscopes of to-day; like them, it has a rapid sliding motion and a slow motion effected by a screw. Next to this were two Microscopes of Scarlet and Culpepper, which made their appearance in England about 1738. In these instruments the body-tube slides in a second tube supported on three feet; the stage is fixed, and the illumination is by a mirror movable in all directions, mounted on a foot.

Several Microscopes of Cuff dating from the middle of the 18th century served to show the progress which had been made in Microscope construction. They were provided with numerous objectives fitting into each other, with micrometer-screw, diaphragm, free stage, mirror and lens for the illumination of opaque objects. A Microscope by Brander

(about 1745) was even more perfect, for, besides an excellent slow motion by micrometer-screw, identical with that adopted about 1835 by the German and French opticians, it also carried a micrometer-screw in the eye-piece.

Amongst other Microscopes of the 18th century exhibited was one of Dellebarre, presented to the Académie des Sciences de Paris in 1778, an inclining Microscope of Navin, a very fine instrument in copper gilt, with a curious slow motion and a screw motion allowing the horizontal displacement of the body-tube; and, lastly, the Microscope which was presented to Buffon by his pupils in 1748. Of the instruments of the beginning of the present century, the Microscope of Selligue, the universal Microscope of Ch. Chevalier, and the achromatic Microscope of Amici were the most conspicuous in the perfection of their design and workmanship.

(2) Microscopes and their Accessories.—The number of opticians who exhibited instruments was altogether only eight, viz. Powell and Lealand, and Watson and Sons, representing England; Hartnack, Leitz, Seibert, and Zeiss, Germany; Reichert, Austria; and Nachet, France.

The firm of Ernest Leitz exhibited eight Microscopes, designed more particularly for medical and bacteriological researches. Their stand Ia. is similar to the one figured in this Journal, 1889, p. 439, except that it is provided with a rotating stage, which can be centered by a screw. The Abbe condenser is moved by rack and pinion, and the iris-diaphragm can be displaced laterally by means of a pinion acting on a horizontal rack. The oil-immersion objective $1/12$ of this firm, with numerical aperture 1.30 , was highly commended by the jury of the exhibition for clearness and exceptional resolving power.

The firm of Nachet was well represented. Besides the large model (No. 1) described in this Journal, 1886, p. 837, they exhibited a very perfect instrument specially designed for bacteriological work. Several instruments for photomicrography were shown by this firm; amongst them a large inverted Microscope for very high magnifications. The whole apparatus is, to avoid tremors, supported upon a large vertical tube which forms the base. Amongst the specialities of this firm, the adapter, which renders the change of objectives in their instruments so simple and easy, is most worthy of notice.

Powell and Lealand only exhibited one instrument, their stand No. I., which needs no description here. Accompanying the Microscope were their three apochromatic objectives, the $1/4$ in. dry, aperture 0.95 , the $1/8$ homogeneous immersion of aperture 1.40 , and the $1/10$ homogeneous immersion of aperture 1.50 , as well as compensating eye-pieces and apochromatic condensers.

The firm of Hartnack exhibited their stands IV., V., and VI. In these the Abbe condenser has the usual disposition, and is provided with a slow motion; the iris-diaphragm can be displaced horizontally by rack and pinion. The special models for bacteriological work, like those of Zeiss, Leitz, Reichert, and Nachet, have a far from graceful appearance, owing to the wide separation of the body-tube from the vertical axis of the micrometer-screw. This mode of construction, which is rendered more unsightly by reason of the shortness of the Continental tube, is

adopted, it is confessed, with the wholly unnecessary object of having a stage large enough to carry cultivation-plates.

M. Hartnack also exhibited a very remarkable photomicrographic apparatus, consisting of a Microscope in a horizontal position connected with the camera, which was on a stand supported by five levelling screws. The camera has some interesting peculiarities. The spindle which acts on the micrometer-screw fits into the centre of the support instead of being placed at the side, as in most instruments; the pinion which transmits the movement to the screw-head of the slow motion, does not act directly, but through the intervention of a system; the result of this is that the initial velocity given by the hand is considerably reduced, and accordingly the focusing is rendered more easy and precise.

The firm of W. and H. Seibert exhibited several of their instruments, readily distinguished by their characteristic appearance from those of other makers. In these Microscopes the screw-head of the slow motion is at the top of the vertical column which supports the instrument. In the stand No. I. there are three motions of the body-tube, the coarse movement by rack and pinion, the ordinary slow motion with the screw-head below, and a third extra slow motion, for use with very high magnifications, in front of the column which supports the body-tube. To this model can be fitted either a rotating stage or one provided with rectangular movements. Their stand No. II. is similar, but does not possess the extra slow motion. Stand No. III. is smaller, but, like the others, it can be inclined and fixed at any angle, and is provided with a rotating stage, Abbe condenser, and iris-diaphragm.

W. Watson and Sons, amongst other instruments, exhibited the Microscope, designed by Dr. Van Heurck, which is described in this Journal, 1891, p. 399, and met with such severe criticism from Mr. Mayall.

The firm of Carl Zeiss was very fully represented. Most of the large models, as well as the large photomicrographic and projection apparatus of this firm, have been described and figured in this Journal. One of the specialities of this firm is a sliding adapter. It consists essentially of a mortise slightly inclined in order to prevent displacement of the tenon on which the objective is screwed. This tenon is formed of two pieces, the lower one of which carries the objective, and can be moved from back to front by means of a screw. A second screw, fitted to the sliding piece, gives a movement from right to left.

The firm of Carl Reichert exhibited several of their stands. The new large model Ia. is provided with a circular stage rotating on its axis after the English system. The movable stage, also for use with this model, admits of an exact displacement of about 25 mm. in two perpendicular directions. The stand II. is of simpler construction. In this model the illuminating apparatus is so arranged as to allow of the rapid change from illumination by the Abbe condenser to the ordinary illumination by the mirror.

The stand No. VII. of this firm is a useful instrument for students, or even for the laboratory. The stage is circular and very large; the micrometer-screw is sufficiently good to allow of the use of immersion objectives. Perhaps the most remarkable point about this instrument

is its price, which is only 65 francs. One of the specialities of this firm are the semi-apochromatic objectives.*

The firm of Reichert also exhibited two forms of microtome. In one of these the object is moved in a vertical direction by a micrometer-screw, up to a limit which can be regulated at will. In the other form, the object is moved by micrometer-screw in an inclined plane.

(3) Instruments and Apparatus of Bacteriology.—The Municipal Observatory of Paris exhibited a great variety of apparatus for the analysis of air and waters. The so-called aeroscopic methods of Pouchet, Pasteur, and others occupied a large place in this exhibition. In the most recent registering aeroscope, the plate covered with lichen jelly on which the atmospheric dust is deposited, is provided with a clockwork arrangement which gives a circular movement to a glass disc on which 24 divisions, corresponding to the 24 hours of the day, are engraved.

The firm of Adnet exhibited various sterilizers and stoves of Sorel, Schribaux, Miquel, and others. Other exhibitors in this section were Wiesnegg, Seibert, and Trouvé.

(4) Micrographic preparations, Photomicrograms, Works of Microscopy.—In this section an interesting exhibit consisted of 550 preparations used by Dr. Van Heurck in the publication of his important work on the diatoms of Belgium.

Prof. Bolsius exhibited his new stage which allows of a lateral movement of 72 mm., and 10,000 sections which served in his researches on the segmental organs of the Hirudinea.

The exhibit of Mr. J. Deby included a large International Microscope of Messrs. Beck, with various accessories, a mineralogical Microscope of Seibert and Kraft, 50 slides representing the complete anatomy, by longitudinal and transversal sections, of *Brugmansia Lówei*, 30 sections of *Hydnophyton formicarium* and *Myrmecodia tuberosa* from Japan, &c.

Other exhibitors in this section were Tempère, Keller, Thum, and Möller.

Photomicrograms were exhibited by Dr. Van Heurck, Jules Van den Berghe, Otto Muller, M. Gife, Andrew Pringle, and others.

Simple Method of Drawing Microscopical Preparations.†—Mr. A. Hopewell Smith writes:—"There has always been a certain amount of difficulty attending the use of the camera lucida or Beale's neutral tint reflector for the above purpose. The twisting of the head into an uncomfortable position, the great fatigue to the eyes, and the by no means easy task of viewing both image and pencil at the same time, add to the troubles of making a faithful likeness of the object on paper.

To those especially who do not possess a camera lucida, or Beale's instrument, and to microscopists generally, I recommend the following arrangement of ordinary apparatus:—The Microscope body is placed in a horizontal position, and the mirror removed from its substage attachment. The Microscope slide having been placed on the stage, the illuminant (lamplight for choice), is condensed on the slide by means of a bull's-eye in the same way as for photomicrography. Care must be taken to centre the light. The concave mirror is then

* See this Journal, 1890, p. 93.

† Journ. Brit. Dental Assoc., xiii. (1892) pp. 78-9.

attached to the front of the eye-piece of the Microscope by a piece of thin wood or a spring, and has its surface at an angle of about 45° with the plane of the anterior glass of the ocular. The image is thus projected on to the paper beneath. No distortion will occur if the outer ring of light is *perfectly* circular. A dark cloth, such as photographers use, is thrown over the draughtsman's head, and also the body of the Microscope, and all light excluded save that through the Microscope lenses. Any section can thus be easily, rapidly, and comfortably drawn, and accurate representations of objects magnified up to 500-600 diameters can be obtained."

Walter H. Bulloch.—Mr. H. L. Tolman, President of the Illinois State Microscopical Society, communicates the following notice:—"The death of Walter H. Bulloch, of Chicago, the eminent Microscope-maker, is a severe loss, not only to our Society, of which he was for nearly twenty years a prominent member, but to the cause of science at large, and a short sketch of his life and work will not be uninteresting. Mr. Bulloch was born in 1835, at Glasgow, Scotland, and lived there until he was seventeen years of age. About 1852, the family emigrated to New York, where Walter learned the trade of tailor with his father. But his innate fondness for mechanical pursuits made him dissatisfied with his prospects, and he was apprenticed to Messrs. Pike and Sons, then a leading firm of opticians and instrument-makers, on Broadway, New York City. After serving his time, he went into business on his own account, until the war of the rebellion broke out, when he enlisted as a private in the 12th N.Y. Volunteers. His term of service, however, was very short, as he contracted a severe cold, which developed into rheumatism, incapacitating him from further work, so that he was mustered out of the service. Returning to New York, he formed a partnership with William Walcs, the well-known maker of objectives, and continued in business there until 1866, when he moved to Chicago. He was very successful, and had accumulated considerable means, when his shop and tools were destroyed in the memorable Chicago fire of October 8-9th, 1871, and Mr. Bulloch sustained a financial loss from which he never recovered. Immediately after this misfortune he went to Boston, and was for a time connected with the late R. B. Tolles, but soon returned to Chicago. In 1888, he accepted a position in the Bureau of Weights and Measures, under the Government, but he chafed under the restraints of an official situation, and after six months' experience returned to his home here. Before he left his health had begun to fail, and after his return late in the fall of 1890, he suffered still more. But his indomitable perseverance led him to struggle on. He opened a place at 303, Dearborn Street, in a very advantageous business portion of the city, and began work again. It was not for long. After struggling with disease for about six months, he was compelled to stop work for ever. He died Nov. 5th, 1891.

Mr. Bulloch was a man of pronounced character and indomitable energy and perseverance. To those who did not know him well, he appeared brusque and sometimes even overbearing, but his numerous friends soon learned to appreciate his straightforward manner of expressing his views, his pertinacious but just demands for a proper recognition of his rights, and his outspoken criticism of what he

deemed erroneous in the theories or opinions of others. In his business he was conscientious and painstaking to a fault. Often when making an instrument or piece of apparatus to order, if he saw where there was room for improvement, he would spend hours or days in experiments, perhaps wasting all the results of his previous labour, refusing to slight his work at any cost. Whether it was the simplest accessory or the finest Microscope stand, nothing was allowed to leave his work-bench until it was as perfect as his trained hand and eye could make it. His reputation was more than money, and he lived to see his fame world-wide. Besides being a member of the Illinois State Microscopical Society, he was a member of the Chicago Academy of Sciences, the American Society of Microscopists, and of the Royal Microscopical Society of London. His death leaves a gap in the rank of scientific workers which cannot easily be filled."

β. Technique.*

(1) Collecting Objects, including Culture Processes.

Simple Apparatus for Cultivation of Small Organisms.†—Prof. Marshall Ward describes a simple apparatus for the cultivation of small organisms in hanging drops and in various gases under the Microscope. The two ends of a piece of thick-walled glass tubing about $\frac{3}{4}$ in. in diameter and 3 in. long, are softened and slightly drawn to narrow tubes, not too thin. One face of the now central bulb is ground flat until a hole about $\frac{1}{2}$ in. in diameter is cut through; a similar hole is then ground on the opposite face of the bulb. The glass is sterilized at 150° C. and cemented by paraffin (or by gelatin in acetic acid) by one of its ground faces to a broad glass slide properly sterilized. Sterilized cotton wool is stuffed into the two narrow tubulures, and the hanging-drop culture, properly prepared on a sterile cover-slip, is cemented over the upper hole of the chamber. If it is necessary to pass gases into the culture one of the stuffed tubulures is connected by means of caoutchouc tubing (sterilized in corrosive sublimate, absolute alcohol, and boiling) with the appropriate gas apparatus. If a very strong cover-slip and careful cementing are employed a very good partial vacuum can be obtained and even retained for some hours. The apparatus seems to be adapted for many kinds of examination.

Macaroni as a solid Nutrient Medium.‡—Prof. G. de Lagerheim recommends macaroni as a substitute for potato. Macaroni as white as possible, and having a diameter of 5 mm. and a lumen of 3 mm., is broken up into pieces of 4.5 cm. and placed in a sterilized test-tube, and then water sufficient to cover the macaroni by 1 cm. is poured in. The tube is then heated for about a quarter of an hour, by which time the macaroni is soft and swollen; the water is then carefully poured off and the test-tube, having been plugged with cotton wool, is steam-sterilized. Thus

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, &c.; (6) Miscellaneous.

† Rep. Brit. Ass., 1891 (1892) pp. 678-9.

‡ Centralbl. f. Bakteriöl. u. Parasitenk., xi. (1892) pp. 147-8.

prepared the macaroni is almost quite white, and hence for chromogenic bacteria is an effective medium as the coloured colonies show up well against the white backing.

Preparing Ammoniated Gelatin, and cultivating Bog-water Bacilli.*—For cultivating various Schizomycetes, Hert F. Pohl recommends gelatin which has been alkalinized by means of carbonate of ammonia, and this medium seems specially adapted for putrefactive organisms and for the long series of spirilla, for the development of which an alkaline medium and much oxygen are necessary.

Gelatin cannot be alkalinized with carbonate of ammonia directly, and sterilized in the usual way, for then it very soon liquefies and loses its capacity for setting. The gelatin and carbonate of ammonia must be sterilized previous to being mixed, although for safety the mixture may be heated in a water-bath for half an hour, but not longer, otherwise the ammonia will have volatilized and the gelatin will not set.

The gelatin was made up with bog-water, and the medium used for cultivating bog-water bacilli, of which four new species are described by the author, *B. stoloniferus*, *B. incanus*, *B. inunctus*, and *B. flavescens*. Besides gelatin, agar and potato were used as cultivating media, and their behaviour towards starch, milk, and sugar was also examined. None were pathogenic; the first two turned sugar into alcohol, but diastase, indol, and phenol were not detected; the last two possessed strong liquefying action, peptonized milk without coagulating it, and converted sugar into alcohol.

Epidemics among Mice kept for experimental purposes.†—Prof. L. Loeffler narrates the history of two epidemics among the white mice kept for experimental purposes at the Hygienic Institute at Greifswald.

In the first he was able to identify the micro-organism found in the bodies of the mice with the microbe of mouse septicæmia, an interesting discovery, because the infection had in all probability attacked the animals through the digestive tract, while it was first described by Koch as being intimately associated with experimental (artificial) traumatism. The total loss of life in this epidemic was fifteen.

In the second epidemic 31 out of 45 animals died in the course of four weeks. The dead animals were found partially eaten; it was therefore probable that the disease had been handed on. The post-mortem appearances were variable, the most prominent being a swollen brownish-red firm spleen, inflammation of the intestinal mucosa and swelling of the mesenteric lymphatic glands, a collection which at once recalls enteric fever. From all the dead mice was isolated a short bacillus, showing lively movements when observed on the hollow slide, and having numerous flagella when stained by means of an alkalinized mordant.

The bacilli were cultivated on the usual media—gelatin, agar, blood-serum-pepton-sugar-bouillon, potato and milk. Neutral fluid media were rendered acid, gas bubbles were disengaged, and by the iodoform reaction alcohol was demonstrable in the distillate. Sections of the diseased organs showed that the bacilli were chiefly massed in the

* Centralbl. f. Bakteriöl. u. Parasitenk., xi. (1892) pp. 141-6.

† Ten. cit., pp. 129-41.

capillaries, and formed aggregations similar to those found in enteric fever, whence the author calls this bacillus *B. typhi murium*.

From experiments made with this bacillus the author found the duration of the disease to be thirteen days, and that the virus was introduced into the system through the digestive tract, and concludes that the great sensitiveness of certain kinds of mice to this microbe suggests the possibility that it may be of great practical value in husbandry. The experiments further showed that the short-tailed field mouse (*Arvicola arvalis*) was extremely sensitive to the presence of *B. typhi murium*, while the long-tailed field mouse (*Mus agrarius*), cats, rats, dogs, small singing birds, pigeons, guinea-pigs, and rabbits were quite unaffected by it.

The author concludes by speculating on the origin of the disease, negating the hypothesis that the *B. typhi murium* might be a variety of some of the pathogenic bacteria studied from time to time in the Greifswald Institute, and that it was due to something in the food; the latter supposition is disproved by the fact that only mice in a particular cage caught the disease. Altogether three epidemics of this disease have occurred.

Fodor's Bacteria-fisher.*—Prof. J. Fodor has devised an instrument which he calls a bacteria-fisher, for removing from a cultivation plate a specimen of any particular colony, with certainty and without contamination. The apparatus, no illustration of which is given, is mounted on a Microscope stand, and consists of a series of rods and rings, fixed at various angles, and maintained in position by screws. At the end of the apparatus is a glass rod carrying a platinum needle. By altering the length of the various rods, and fixing them at different inclinations, the needle is brought under the Microscope, and in contact with the colony from which it is desired to remove a specimen. By this means tolerable certainty is arrived at, as the trembling of the hand is avoided, and the position of the needle can be seen.

Bacteriological Examination of Water.†—Dr. F. Kräl, in order to obviate the great inconvenience arising from the size of some of the apparatus employed in the bacteriological examination of water, has devised an apparatus consisting of so many flat glass capsules fitting in a case. Each capsule has a diameter of about 9 cm., the sides are 4 mm. high, and the glass 1 mm. thick. The top and bottom of these capsules are quite flat, and can therefore be placed directly under the Microscope. Twenty of such covered capsules are, when piled one on top of the other, about 15 cm. high.

In order to hasten the setting of the gelatin, or to prevent any subsequent liquefaction, a double tin case may be used, so that the jacket can be packed with ice.

Keeping Cestoda alive.‡—Dr. E. Lönnberg records some fourteen experiments made for the purpose of keeping Cestoda alive under artificial conditions. *Triænocephorus nodulosus*, a parasite of pike, was selected because it is easy to obtain. The basis of the medium was a slightly

* Centralbl. f. Bakteriöl. u. Parasitenk., x. (1891) pp. 721-2.

† Op. cit., xi. (1892) pp. 19-20.

‡ Tom. cit., pp. 89-92.

acid pepsin-pepton solution, containing from 3 to 4 per cent. of nutrient, and less than 1 per cent. of NaCl. In most experiments some slight modification was adopted, e.g. more water, olive oil, grape sugar, &c., were added. In the least unsatisfactory experiment the worms lived from the 26th of one month to the 28th of the next.

The great difficulty in the way of a signal success seems to have been the occurrence of putrefaction in the medium, which had frequently to be changed.

The author thinks that the composition of the medium has less to do with the unfavourable results than the decomposition, since the particular medium in which the worms survived for more than four weeks little resembled the conditions natural to the animal.

It is considered that these experiments favoured the notion that besides requiring a suitable temperature and certain mechanical conditions, the development of tape-worms within the host is aided or prevented by the reaction of the intestinal contents, e.g. too great acidity being inhibitive.

Collection and Preservation of Diatoms.*—M. J. Tempère gives instructions in the best mode of collecting and isolating diatoms, and preparing them for examination. A convenient form of pocket-drag is described, made of metal, which can be used for rocky bottoms or places encumbered with solid bodies. A list is appended of all the more important beds of fossil diatoms.

(2) Preparing Objects.

Study of Structure of Protoplasm.†—The editor (Dr. A. C. Stokes) writes:—"According to Heitzmann, Klein, and several German observers, animal protoplasm is a network of fibrils radiating in all directions through the cell, and containing a homogeneous fluid within its meshes. This and other inclosures have been referred to in an admirable manner by Prof. Kirsch in his valuable series on cytology; but a sight of this reticulation within the cell is one that has been most desirable for every microscopist, but that to the amateur has been especially difficult. The appearance of the structure has been repeatedly figured, but the sight of a picture is not to be compared in satisfaction to the sight, although it may be an imperfect one, of the object itself. This has heretofore not been an easy task, but through no discovery of my own it has recently come to my knowledge that there is a common animal in whose intestinal cells this structure of the protoplasm may be observed with comparative ease and with lively satisfaction. The animal is . . . *Oniscus murarius*. In order to see the appearances as described by certain observers I sought the *Oniscus*, and in five minutes had gathered a dozen. . . . Kill an *Oniscus* by a few drops of alcohol. Remove the legs, to get them out of the way. With fine-bladed scissors slit up the body on the lower or abdominal side. Push away, or carefully remove, the walls of that part of the body, and the intestine will be in plain sight. It is a nearly straight, tubular vessel, large for the size of the animal, and usually gorged with food or its remains. It is

* Le Diatomiste, i. (1891) pp. 41-2, 46-7, 61-4 (3 figs.).

† Microscope, xi. (1891) pp. 276-8.

a conspicuous object, and may be readily removed. After removal it must be slit open, so that the inner surface shall lie upward toward the objective. To do this, my plan is with great care to insert a fine needle into the lumen, the cavity of the intestine, and when the tube has been placed on the steel without having its wall pierced at any point, it is gently rubbed with another needle until it is slit from end to end. This is not a difficult thing to do if the needle be fine and the microscopist's hand be steady. After the intestine, or a part of it, has been taken from the body, all subsequent manipulations may and should be performed on the slide and in the cell in which it is to be mounted.

The intestine, slit open, is then placed in a small drop of water, and while it still remains attached to the needle is to be gently freed by another needle and floated in the water, inside upward. The intestinal contents are then to be washed away by the repeated dropping of water. When thoroughly cleaned, as may be known by the disappearance of all the brownish feces, drain off the water and add one or two drops of a solution of methyl-green, one of the anilin stains to be had of the dealers in microscopical supplies. The dye acts rapidly, so that from four to five minutes will usually be long enough to colour the parts sufficiently. Wash away the superfluous stain, drain off the water, add a drop of diluted glycerin and apply the cover-glass, cementing it in place with shellac.

A small piece of the intestine is all that is needed; it is not necessary to take the entire intestinal tube. I have found the rectum, the posterior region nearest the external aperture, to be free from faecal matter, and beautifully transparent. In this part, too, the cells may be rather better displayed than in anterior regions. The cells are comparatively immense, with conspicuous cell-walls, prominent nuclei with their inclosed nucleoli, and with the structure of the protoplasm finely displayed. The latter may be seen well with a good 1/5-in. objective, but of course with greater satisfaction under a lens of higher power.

A close, small meshed network of the protoplasm does not seem to be a constant and invariable feature of its structure, although in many cells it is exquisitely demonstrable, while in many others it is composed of exceedingly fine fibres radiating in every direction from the centre toward the cell-wall and forming meshes so narrow that they are very inconspicuous, really demanding somewhat careful search to see them. Here the fibrillated structure dominates, and this appearance calls to mind the aspect of an almanac sun, the face of the symbol being here represented by a somewhat irregular nucleus, with fine rays increased to an indefinite number.

While examining these large and beautiful cells the observer should bear in mind these two appearances, and not be disturbed if the network is not as plainly visible and the meshes as close, small and regular as he expected they would be. In my experience the fibrils are the most readily demonstrated, unless a very high power, a 1/12 or higher, be used to study the protoplasm surrounding the tubule of the nucleus and situated between it and the membrane including the nucleus and separating it from the protoplasmic contents of the cell. In this part of the object the reticulum, or network of delicate fibres, is superbly demonstrable.

Those that have been reading Prof. Kirsch's paper on cytology have learned that the nucleus, while it appears to be formed of a reticulation or network, is in reality composed of a single fine tubule much convoluted upon itself, the apparent network being produced by the crossing of the tubule over its preceding convolutions. The nucleus is in structure only a single, very much twisted tube, whose hollow is filled with a substance that has been named the nuclein. In the intestinal cells of *Oniscus* beautiful optical sections of this are obtainable, since the nuclein takes the stain with great avidity. The network is here conspicuous, and the meshes, unlike those of the protoplasm of the cell, are fine and small. Altogether, therefore, the intestinal cells of this common animal cannot be excelled as objects in which to examine the structure of the protoplasm—a subject that is always interesting, and should be seen and understood by every microscopist."

Methods of Technique in Embryology of Frogs.*—Mr. T. H. Morgan describes his methods as follows:—"The eggs, during the periods in which it is difficult or impossible to remove the inner jelly membrane, can be freed in the following manner. With a pair of sharp scissors each egg must be cut out from the general jelly-mass, retaining as small an amount of surrounding jelly as possible. It is then put into an alcoholic solution of picric acid for an hour or longer (one to twelve). The solution is prepared by saturating 35 per cent. alcohol with picric acid, and adding the same amount of sulphuric as in Kleinenberg's solution. The solution is not diluted, but used saturated with picric acid. The eggs are then washed for several hours in 35 per cent. alcohol, several hours in 50 per cent. alcohol, and placed in 70 per cent. for several days, changing the alcohol once or twice if necessary. About the second day the inner membrane begins to swell, due to a slow osmotic action, I think, as the membrane is stretched by tension from within. On the third or fourth day the swollen membrane may be pierced by a sharp needle, and the egg taken out, which is then placed permanently in 80 per cent. alcohol. The method is exceedingly simple, and consists largely in waiting a few days for the osmotic action to take place. Such eggs, if properly prepared, are in excellent histological condition. This simple method has proved so successful that I have not further experimented with it. It is possible that it may be improved by varying the strength of alcohol used, but I have not seen the need of looking further. The membrane does not swell in stronger alcohol than 70 per cent., and weaker would macerate the eggs.

Certain precautions are necessary in imbedding the eggs to prevent brittleness. This is obviated by soaking the eggs before imbedding, for several hours, in a solution of turpentine saturated with paraffin, and kept in a warm place—not so hot as the water-bath (50° C.). Heat causes the egg to become brittle. This is obviated by the above process of soaking, so that the egg need not remain so long as an hour in the melted paraffin of the water-bath.

In the younger stages there is no need for very thin sections, but sections 10 μ thick are sufficient for all purposes. If the sections are cut too thin the yolk tends to break up and crumble."

* Amer. Nat., xxv. (1891) pp. 759-60.

Observation of the Process of Fecundation.*—M. L. Guignard recommends the following method of preparation for observing the various stages in the process of fecundation, whether of animals or plants, especially the part played by the “directing spheres.” The best fixing material is absolute alcohol, either pure or with the addition of from 0·2 to 0·3 per cent. of corrosive sublimate or picric acid. A 1 per cent. aqueous solution of sublimate, a saturated solution of picric acid, and a 0·5 per cent. solution of chromic acid, also give good results. In treating the cells themselves with vapour of osmic acid, it is necessary to note the exact time necessary and sufficient for complete fixation, too long exposure injures the staining. The preparation may then be hardened, first with Flemming’s fluid, then with absolute alcohol. Flemming’s fluid does not answer so well with tissues which are to be fixed *en masse*, such as pollen-cells or ovules, as with the contents of the embryo-sac extracted from the ovule after fecundation. The best staining reagent for the “directing spheres” is hæmatoxylin.

Study of Spermatogenesis.†—Dr. C. Pictet recommends three modes of procedure in the investigation of the delicate seminal cells—examination of living cells, various modes of dissociation and examination in more or less indifferent fluids, and sections. The last, however, is of little use. Examination of the living cell is most important, as there is no known reagent that does not alter it. The nucleus has generally been studied in a solution (1 per cent. to 3 per cent.) of acetic acid in water; dahlia (St. George’s formula) or methyl-green (Carnoy) have been almost exclusively used as staining reagents. Good preparations have been obtained by the vapour of osmic acid, followed by pyrogallie acid; and by chloride of platinum and permanganate of potash. It must be remembered that the accessory nucleus is destroyed by acetic acid; when that body is to be retained, it is advisable to use a watery solution (5 per cent. to 10 per cent.) of chloride of manganese, to which a few drops of a concentrated aqueous solution of dahlia have been added; this reagent is strongly recommended by the author.

Study of Development of Oviduct of Frog.‡—Mr. E. W. MacBride prepared his tadpoles either with corrosive sublimate or with Perenyi’s fluid and alcohol. Decalcification was effected by nitric acid in strengths varying from 1 to 10 per cent.; strange to say, no difference was observed with different strengths, but a 3 per cent. solution for twenty-four hours may be recommended. Material preserved in picric acid was found to be quite unsuitable. The method of study was solely that of a series of transverse sections, but it is well to first remove the greater part of the gut, almost all the liver, the heart, and most of the lungs.

Study of Neomenians.§—M. G. Pruvot found that the best fixing reagent was corrosive sublimate concentrated at freezing-point; coloration *en masse* was very well effected in three or four hours by alum-carmine. Double staining, after sectionizing, by a watery solution of hæmatoxylin and eosin gave very fine preparations; it has the advantage

‡ * Ann. Sci. Nat. (Bot.), xiv. (1891) pp. 166-9.

† Mittheil. Zool. Stat. Neapel, x. (1891) p. 75.

‡ Quart. Journ. Micr. Sci., xxxiii. (1892) pp. 273-4.

§ Arch. Zool. Expér. et Gén., ix. (1891) pp. 701-2.

of not destroying, as does alum-carmine, calcareous spicules, and certain elements, such as those of mucous glands, are much better stained by it; these glands are, however, preferably stained with methyl-green, which has a remarkable power of selecting mucus. After staining, the sections should be placed for a few seconds in a very weak alcoholic solution of methyl-green.

Preparation of Gastrulæ of *Aurelia flavidula*.*—The embryos examined by Mr. F. Smith had been killed with picro-nitric acid and preserved in 90 per cent. alcohol for three years. Ehrlich's acid hæmatoxylin was found to be the best staining reagent for sections. Czokor's alum-cochinal stains embryos of different ages with corresponding degrees of intensity, increasing with the age of the embryo.

Examination of *Spongiicola fistularis*.†—Mr. W. R. Melly found it very difficult to kill this curious medusoid in an extended condition. The best specimens for sections were those treated for two minutes in 1 per cent. osmic, and then passed through various stages of alcohol up to 90 per cent., hardened in absolute, and imbedded in paraffin. It was found best to leave the *Spongiicola* in the Sponge, and dissect it out after hardening in absolute alcohol.

A Medium for preserving the Colours of Fish and other Animals.‡—Mr. A. Haly, Curator of the Colombo Museum, has for some years been making experiments to discover a medium which will preserve the colours of fish and other animals. The following is taken from the last Annual Report of the Colombo Museum:—“In my last year's report I made some remarks on the use of carbolized oil as a mounting fluid for specimens already prepared by other means, the idea that it was a preservative in itself not having occurred to me. Further experiments this year seem to show (I do not like to speak too confidently in a climate like this, even with twelve months' experience) that it is one of the most perfect preservatives known both for form and colour.

Coco-nut oil and carbolic acid freely mix in all proportions. The mixtures at present under trial are oil raised to the specific gravity of 10° and 20° below proof-spirit by the addition of acid. Whilst the gum and glycerin process is absolutely useless for any animals, except certain families of fish, this mixture is good for every kind of vertebrate. The most delicate frogs are quite uninjured by it, and snakes undergo no change. The delicate plum-like bloom on the geckoes, the fugitive reddish tint on such snakes as *Ablabes humberti*, are beautifully preserved by it.

Another most important use is in the preservation of large fish-skins, which can be packed away in it for an indefinite period, and mounted when wanted. These skins do not require varnishing, neither do they turn brown, but although, of course, they do not preserve their sheen like fish in the oil itself, they always maintain a silvery and natural appearance, quite different from that of ordinary museum specimens. If ever we get a new fish gallery, a show of our large species prepared in this way would form a most effective exhibition.

* Bull. Mus. C. Z., xxii. (1891) pp. 115-6.

† Rep. Brit. Ass., 1891 (1892) pp. 367-8.

‡ Nature, xlv. (1891) p. 212.

It appears also to be a most excellent preservative for Crustacea and the higher orders of Arachnida; and also for centipedes, but it has hitherto proved a failure for marine invertebrates in general. It must be remembered, however, that the perfect miscibility of the two liquids opens up endless possibilities. Its absolutely unevaporable nature makes it invaluable in a tropical climate, quite apart from its other qualities.

With regard to this last remark I take the opportunity of stating that the acid enables coco-nut oil and turpentine to be mixed together. This forms a splendid microscopic fluid, in which objects may be allowed to soak without any previous preparation, and in which they become very transparent. A minute species of Crustacean, of the order Copepoda, and the leg of a fly, simply laid on a slide in a drop of this fluid and covered with an ordinary covering-glass, without any cell being made or cement employed, have lain on my table unaltered for the last ten months, and I cannot help thinking that such a medium as this cannot fail to prove a great boon to all workers with the Microscope."

Method of making Leaves transparent.*—Dr. A. C. Stokes writes, "It frequently happens that the amateur microscopist would study the epidermal cells and appendages of the almost infinite variety of leaves, the structure of the cellular parenchyma, or body-substance of the leaf, the peculiarities of the cells and vessels of petals and of other parts of flowers. That is, he would if he could. It is sometimes an easy task to strip off the epidermis and to examine its cells, while in other cases it is almost impossible. Many chemical mixtures have been recommended for the purpose, and they accomplish the object after a fashion. The structure of the body of the leaf may be satisfactorily studied in sections, but not every microscopist can have a good microtome—a poor one is an abomination. There is also much to be learned and much beauty to be seen in the petals of flowers and in the cuticle and cells of the anthers, but it has been almost impossible to succeed here without special and somewhat complicated processes. Yet there is a way to make these objects either entirely transparent or sufficiently translucent to render their study pleasing and comparatively easy. The dealers will supply the microscopist with mounts of entire flowers, made beautifully transparent, but the method of accomplishing this is not detailed with any spontaneity; indeed the preparers, so far as I have been able to observe, are deaf and dumb when the subject is mentioned in their presence. I possess a fine slide of the entire flower of the common *Houstonia*, or "innocence," perfectly transparent, so that the cells of the epidermis, of the substance of the petals and of other parts, and the anthers with the pollen-grains *in situ*, may all be examined with a high power. How the thing was accomplished I have, until recently, been unable to ascertain. The secret has been so well kept that, so far as I can learn, only the dealers knew it; the books have not discovered it. Yet by a very simple method these objects, as well as leaves, may be made entirely or almost transparent, so that the vessels and the cells may be studied at one's leisure and in comfort.

* Microscope, xi. (1891) pp. 265-7.

By this treatment the hair-like and glandular appendages and stomata are preserved in place and in structure, the protoplasmic contents alone being contracted toward the centre of the cells. It is a method that I have stumbled on by accident, but one that I can recommend to the microscopical botanist that desires to examine these parts without destroying or disarranging any of the constituents.

Place the petal, the anther, the whole blossom, or a part of a leaf on the slide, in a large drop of glycerin. See that it is completely submerged beneath the liquid, and add a large cover-glass. It is best to use a slip without a cell. Then boil the glycerin over the lamp-flame until the parts are entirely transparent or at least translucent, a condition that will arrive in a short time. Do not allow the boiling to be so violent as to disarrange the thin glass; let it be so gentle that the bubbles will run one by one to the edge of the cover and there break. If the glycerin should become discoloured, as will often happen when leaves are under treatment, draw off the liquid by a wet cloth and add fresh glycerin, repeating the process and the boiling until the leaf is saturated. The use of glycerin and the saturation of the cells form the secret of the process. The saturation is easily accomplished with petals and similar delicate parts; with thick and opaque leaves the time demanded is longer, and the specimen may become only translucent. I have made the thick and opaque leaf of the garden geranium, *Pelargonium*, so translucent that there was no difficulty in examining the hairs on the surface, the epidermal cells, the parenchyma and vessels, with the cells of the epidermis on the opposite surface. Of course there is a limit to the thickness and to the opacity that can be overcome, yet the method will be found exceedingly useful. Leaves and petals do not entirely lose their colour, although they become beautifully transparent. Of course the specimens must be permanently preserved in glycerin.

The secret that the dealers have seemed to keep so carefully, and that the books have ignored because apparently their authors had not learned the process, is here placed at the reader's disposal. I am sure that he will be pleased with the result of his experiment, and that he will find the objects so often mentioned, rendered easy of examination. Petals and other parts of the flower need no previous preparation. It is well, however, to cut the leaves so that there shall be two or more open surfaces for the penetration of the glycerin. In some very delicate specimens this will not be necessary; it is so when the leaf is thick or very opaque."

Preparing Agarics.*—M. Fayod says that the best way to preserve specimens of agarics intended for microscopical examination is to let them dry slowly. The best way to do this is to place them in paper capsules and then to inclose them in cardboard boxes.

Such specimens when ready are to be cut dry. The sections are placed in water containing a little ammonia, if the filaments be thick-walled, and in strong ammonia or dilute potash if the wall be thin.

The specimens may also be preserved in spirit, and the spirit may

* Ann. Sci. Nat., ix. (1889). See Rev. Gen. de Bot., iii. (1891) pp. 427-8.

be economized by leaving the preparation only two or three days therein, and then, while still saturated, placing them in a paper capsule, upon which may be written any necessary observations. Numbers of these capsules can then be placed in wide-mouthed bottles plugged with cotton wool soaked in spirit, previous to being corked. Only slices from the middle of large species should be preserved, but the whole specimen should be previously hardened in 80 or 90 per cent. spirit.

(3) Cutting, including Imbedding and Microtomes.

Method for Saturating Preparations with Paraffin.*—Instead of dehydrating tissues or pieces intended for paraffin imbedding, the following method is recommended by Przewoski as being more economical, safer, and more easily applied than absolute alcohol:—After removal from ordinary spirit the preparation is immersed in anilin oil for 24 hours at least. It is then wiped, and the anilin oil removed by soaking in chloroform for 24 hours. It is then immersed in paraffin dissolved in chloroform (40 per cent.), and the next day in melted paraffin, which must be cooled down as soon as possible, to prevent it becoming brittle. The anilin oil may be previously dehydrated by distillation or by dropping a piece of caustic potash therein.

(4) Staining and Injecting.

Demonstrating the Plasmodium Malariae.†—Herr E. Malachowski recommends the following method for staining the plasmodium malariae. Hardening in alcohol, floating the cover-glass in a mixture of eosin solution and dilute aqueous borax methylen-blue solution. The red discs are grey or yellowish-red, the nuclei of white corpuscles red-violet, the plasma of the mononuclear leucocytes blue, that of the multinucleated pale violet, the plasmodia are blue, and certain granules within them, which have some relation to sporulation, red-violet.

Herr J. Mannaberg‡ describes a new method for demonstrating the parasites of malaria. The preparation, dried in the air, is placed for 12–24 hours in a mixture of equal parts of saturated picric acid solution and distilled water to which 3–5 per cent. acetic acid has been added. It is then quite decolorized in spirit, and having been over-stained with alum-hæmatoxylin solution, differentiated with 25 per cent. hydrochloric acid alcohol and dilute ammonia alcohol. By this method the red discs and the plasma of the white corpuscles remain unstained, the hæmatoblasts are faintly coloured, while the nuclei of the leucocytes and the chromatin of the plasmodium are well stained.

The author describes the young plasmodium as consisting of a thin layer of non-pigmented plasma, a large round nucleus situated eccentrically, and containing a nucleolus. In process of time the plasma differentiates into two layers, an ecto- and endoplasma; and ultimately the plasmodium is distinguishable into its plasmatic and nuclear halves.

* Centralbl. f. Allgem. Pathol. u. Pathol. Anat., 1890, No. 26. See Bull. Soc. Belge de Microscopie, xliii. (1891) pp. 12–13.

† Centralbl. f. Klin. Med., 1891, pp. 601–3. See Centralbl. f. Bakteriöl. u. Parasitenk., x. (1891) p. 706.

‡ Tom. cit., p. 513. See Centralbl. f. Bakteriöl. u. Parasitenk., x. (1891) pp. 705–6.

In the nuclear half small granules appear, "the nucleoli of the spores," which later on develop a nucleus and plasma. The plasmatic half seems sometimes to participate in this process of subdivision, and sometimes to take no share in it.

New Method for demonstrating Tubercle Bacilli on cover-glasses and in sections.*—Dr. C. Arens communicates the following method, which he says is quick and safe for demonstrating tubercle bacilli. It consists in staining sputum with a saturated alcoholic solution of fuchsin diluted with chloroform, and decolorizing with a solution containing hydrochloric acid (HCl, 10; aq. dest., 260; alcohol, 90 per cent., 730).

Sputum.—A fuchsin crystal the size of a millet-seed is put in a watch-glass together with 2 or 3 drops of absolute alcohol, or 3 drops of a saturated alcoholic solution of fuchsin may be used. To this solution 2-3 ccm. of chloroform are added, and when precipitation has ceased and all cloudiness disappeared, the cover-glass is stained (4-6 minutes) in the ordinary way. The chloroform is allowed to evaporate and the preparation decolorized in 96 per cent. spirit, to which 3 drops of HCl are added. It is then washed and may be examined in water straight away or be after-stained with dilute methylen-blue.

Sections.—These are removed from spirit to the chloroform-fuchsin solution and stained for 4-6 minutes, decolorized with the acidulated spirit, the acid washed out with strong spirit, and contrast-stained with dilute methylen-blue.

Influenza Bacillus, and methods for obtaining and demonstrating it.†—Herr Pfeiffer has found in the sputum of influenza, in the peribronchitic tissue and on the surface of the pleura a minute bacillus of about the thickness and half the length of the bacillus of mouse septicæmia. They were seen in the pus-cells, three or four often forming a chain. They stain with Gram's method, with the basic anilin dyes, but best with dilute Ziehl's solution or with hot Loeffler's methylen-blue. Pure cultivations of the bacillus were made in 1½ per cent. sugar-agar. Kitasato separated this micro-organism from others mixed up in the oral secretion by growing them on glycerized agar at incubation temperature, whereon they appeared as microscopic drops much like water but never running together. They were cultivated on this medium to the tenth generation. Cultivated in bouillon white flakes appeared, these sank to the bottom, leaving the fluid above quite clear, whence it was inferred that the bacillus is immobile. Inoculation experiments on apes and rabbits were successful, but on no other animals.

The same micro-organism has been demonstrated microscopically in preparations made from blood by Canon. The cover-glass preparations, having been dried in the air, were placed for 5 minutes in alcohol, and then stained for 3-5 hours at 37° C. in Czenzynke's solution (saturated aqueous solution of methylen-blue, 40 parts; 1/2 per cent. eosin solution (in 70 per cent. spirit), 20 parts; aq. destil., 40 parts); they are then washed in water, and having been dried, mounted in balsam. By this stain the blood-discs are stained red, and the white corpuscles and bacilli

* Centralbl. f. Bakteriöl. u. Parasitenk., xi. (1892) pp. 9-10.

† Deutsch. Med. Wochenschr., 1892, Nos. 2 and 3. See Centralbl. f. Bakteriöl. u. Parasitenk., xi. (1892) pp. 148-50.

blue. They disappear from the blood six days after the fever has passed off, and were never found in persons not sick with influenza.

Canon has also obtained cultivations of his bacillus from the blood, although their small number in the circulation enhances the difficulty of this feat. Cultivations were obtained from blood drawn from the finger-tip, and made on glycerinized agar and Petri's capsules. The colonies which grew at incubation temperature quite resembled those described by Kitasato.

Differentiation of Leprosy and Tubercle Bacilli.*—It is often important for pathological purposes to know whether affections are leprosy or tubercular. Dr. C. Slater finds that the distinction cannot be learnt from an examination of the bacilli, for any colouring agent which stains the leprosy bacillus also stains *B. tuberculosis*; the methods proposed to stain *B. lepræ*, while leaving *B. tuberculosis* unstained, are unreliable. Differences have been asserted to exist in the rapidity of staining and resistance to decolorization; but these are due to differences in the number of bacilli present.

We are reminded that stains coming from different manufacturers and different samples from the same maker are very variable in their staining properties. The two red dyes used by Dr. Slater were a magenta obtained from Messrs. Martindale and a rubinfuchsine from König of Berlin.

Staining Bacteria in Fatty Substances.†—Dr. C. Arens stains bacteria in fatty substrata, e. g. milk, in the following way.

A loopful of milk and a loopful of distilled water are mixed on a cover-glass, dried and fixed by gentle heat. The cover-glass is then placed in a watch-glass containing chloroform—methylene-blue made by mixing 12–15 drops of a saturated alcohol solution of methylene-blue and 3–4 ccm. of chloroform. In this solution the cover-glass is moved to and fro for 4 to 6 minutes. The chloroform is then allowed to evaporate and the preparation is washed with and examined in water. In fresh milk and cream only the bacteria are stained, but if curdled the flakes of casein are dyed pale blue, though this does not interfere with the distinctness of the deep-blue bacteria.

Staining Sections of Mosses.‡—The cortical and pericyclic zones of mosses are composed of cells so much alike that it is difficult to distinguish them unless staining agents be used.

M. Bastit first treats them with a solution of tannin, and, after sectioning, with congo red. The tannin acts as a mordant in the cells of the pericyclic zone, these being distinguished by their brighter colour from the cells of the cortical zone. The sections are next placed in a solution of hypochlorite of soda, then of potash, by which the cell-contents are removed, and having been rapidly washed, transferred to a solution of phosphoric acid. Hereupon they become blue, but on being immersed in absolute alcohol the stain is removed except from the parts which have absorbed the tannin.

* Quart. Journ. Mier. Sci., xxxiii. (1891) pp. 219–28.

† Centralbl. f. Bakteriöl. u. Parasitenk., xi. (1892) p. 10.

‡ Rev. Gén. de Bot., iii. (1891) p. 432.

Staining Motor Nerve-endings in Striated Muscle.*—Sig. C. Negro has devised a method for simultaneously staining and fixing muscle, especially suitable for demonstrating the nerve-endings in the muscular tissue of Reptilia. The solution is made of saturated solution of ammonia-alum, 150 ccm., and saturated alcoholic solution of hæmatoxylin (Grübler) 4 ccm. This mixture is exposed to the air for eight days in an open vessel and then 25 ccm. of both glycerin and methyl alcohol are added.

The procedure is as follows. The insertion of the muscle is teased out on a slide, and when this has been sufficiently done some drops of hæmatoxylin solution are added to it. In 15 to 20 minutes it is carefully washed while on the slide and then mounted in a mixture of equal parts of glycerin and water. Put up in this way the preparation will keep for at least two years.

Another method consists in overstaining and afterwards decolorizing. This is done by immersing separated muscle fibrils in the hæmatoxylin solution for 24 to 48 hours, and after washing, to keep the preparation in the glycerin and water until required. The fibril is then teased out on a slide, and if overstained it is treated for 10 to 12 seconds with the following mixture:—Glycerin 40 parts, hydrochloric acid 1 part, distilled water 20 parts.

A too prolonged action of the acid fluid decolorizes the nerve-endings and also affects their structure.

Rapid Staining of Elastic Fibres.†—Sig. E. Burci gets very satisfactory results by using aurantia di-triinitrophenylamine

$$\begin{array}{l} \text{C}_6\text{H}_2(\text{NO}_2)_3 \\ \text{C}_6\text{H}_2(\text{NO}_2)_3 \end{array} \rangle \text{NH.}$$
 The sections, stained with carmino or hæmatoxylin, are washed in water, dipped for one or two minutes in a saturated alcoholic solution of aurantia, washed in absolute alcohol, cleared in clove oil, and mounted in balsam.

New Method of Double Staining.‡—Sig. Pianese proceeds by first preparing Martinotti's solution, a saturated solution of picric acid and nigrosin in alcohol. Two parts of this solution and one part of anilin water are next mixed and allowed to evaporate in the open air. From this are deposited crystals which are dissolved in absolute alcohol. From the latter are obtained cubical crystals of an olive green colour, soluble in water, alcohol, or ether. With these crystals are made a 2 per cent solution in spirit for tissues, in water for micro-organisms.

The sections are first stained either with Beale's carmine or Orth's lithia carmine, and having been treated with acidulated alcohol, are washed and then dehydrated. They are now immersed from two to ten minutes in the alcoholic solution of picro-nigrosin until they assume a brown hue. They are next decolorized in an alcoholic solution of oxalic acid, dehydrated, cleared up and mounted.

By this method the nuclei are stained red, the plasma is a dark

* Boll. dei Musei di Zool. ed Anat. Compar. della R. Unio di Torino, v. (1890). See Bull. Soc. Belge de Microscopie, xviii. (1891) pp. 9-10.

† Atti Soc. Tosc. Sci. Nat., vii. (1891) pp. 251-3.

‡ La Riforma Medica, 1890, No. 155. See Bull. Soc. Belge de Microscopie, xliii. (1891) pp. 13-14.

yellow, the connective tissue a pale green, elastic fibres violet, and cartilage yellow.

If it be desired to stain micro-organisms at the same time as the tissues, the sections are, after having been stained with carmine, decolorized by Gram's method, or by the Koch-Ehrlich method for tubercle bacilli, and then are immersed for five minutes in the aqueous solution of picro-nigrosin, after which the process terminates as above.

(5) Mounting, including Slides, Preservative Fluids, &c.

Combined Method for fixing and flattening Paraffin Sections.*—Mr. H. E. Durham has devised a modification of Canini's method in which alcohol is used as a means of causing sections to adhere to a slide. These sections are placed on a dry slide or are moistened with ordinary methylated spirit diluted to 70 per cent. alcohol. The slide is placed on a horizontal metal plate kept sufficiently warm to soften the paraffin. More alcohol is run on by means of a pipette. As the slide becomes warm the paraffin softens, and any little wrinkles disappear, the sections floating flat on the top of the alcohol. When they all appear flat the excess of alcohol may be removed with a pipette.

When all the alcohol has evaporated, the paraffin may be just melted and then dissolved with benzol or xylol. Canada balsam may then be dropped on and the cover-glass applied, or the slide may be put through absolute alcohol, and stained and mounted as desired.

Care must be taken that the warm plate is not too hot, for if the paraffin melts completely the sections are unsupported. It is claimed for the method that it is much less troublesome than Gaskell's, and quite as satisfactory for even apparently hopelessly crumpled sections.

More about Cements.†—Mr. J. D. Beck remarks:—"Invaluable articles have been written on the nature of cements and varnishes for finishing mounts. I feel my incompetence to enter a field among superior microscopists with my suggestions, except on important points, which, in my opinion, have been overlooked, as I do not recollect to have read any comments as to the applying of anything on top of the cover-glasses of mounts. For objectives of low power this answers very well, if it is a good, hard, and elastic varnish or cement, fixing the cover-glass securely, but when it is desirable to use high power objectives of short working distance, these rings, thus applied, are in the way of the lens, which is more or less liable to injury by contact with the ring of varnish on the cover. I perceive, however, as I look over my collection of slides, that many microscopists never or seldom allow any cement or varnish to rise above the upper surface of cover-glasses. This effectually prevents all trouble with high power objectives, unless the cover is not parallel with the slide, a very common annoyance, but it does not hold the cover as securely as a thin coat of hard and elastic finishing varnish applied around the edge with a very narrow ring on top, being sure that there is no break between the ring at the edge and that at the top.

Many cements have been prepared and are in the market which are

* Quart. Journ. Micr. Sci., xxxiii. (1891) pp. 116-7.

† The Microscope, xi. (1891) pp. 338-41; 368-70.

very defective in preparation and formula. In a former article I recommended Winsor and Newton's picture varnish for finishing mounts. It makes a neat finish, but is not a durable coating. All the cements prepared from dammar, mastic, shellac, gum-arabic, and all the other gums or resins, to my knowledge (except copal, amber, and a resin or gum nearly as colourless and hard as glass, which resisted fifteen solvents, and for which I have not yet found a solvent or a name), all are too soft and brittle, and therefore unfit for cements or varnish.

White zinc cement, according to my collection of mounts and all that I have purchased, and made myself, is the most defective of all cements; it is not necessary to enter into an argument, or a controversy to prove this question with any pet theories. As a practical test, 'the eating is the proof of the pudding.'

When I examine the slides received from Europe and from every State in the Union, I find that the rings of white zinc, shellac, dammar, Brunswick black, marine glue, &c., have prismatic colours between them and the slide, an evidence that the cement has cracked loose from the glass. Some of my own preparations have also cracked and curled up in course of time. My slides are in a cool room seldom heated to 90° F. in the summer, and never below 40° F., in the winter, and not exposed to sudden changes of temperature.

I have resolved to put all cements for my own use to the following practical test: spin a ring on a clean slide and let it harden thoroughly, then push a sharp-pointed scratch-awl or a sharp brad-awl through the ring, cutting a groove just wide enough for the tool to pass.

This repeated a dozen times on one ring should leave sections not less than 1/16 in. long intact, between each incision, and so hard that no impression can be made on the ring with the edge of a stout thumbnail. This I consider a reliable test. But if large sections of the ring fly away, leaving no trace of the cement on the glass when tested in this manner, as do all the white zinc cements that I have bought of the opticians, it is, without any exception, a nuisance.

It is impossible to prepare a good and reliable cement or varnish out of poor or improper materials; nor is it always possible to prepare a good article out of the best material, if improperly proportioned, or if prepared in a hasty and careless manner.

When the best glue or gelatin is soaked in cold water all night, and then boiled in a water-bath till thin, and thoroughly dissolved by frequent stirring and by adding to it prepared chalk, chloride of sodium, glycerin (C. P.), and acetic acid in the proper proportions, we have a reliable cement for mounts and labels that will never crack nor scale off.

I have found the following original formula good; but it may be improved, I think:—

(1) Reduce 6 drms. of dry gelatin to a thin solution in distilled water—soaked overnight cold, and boiled in a water-bath.

(2) Reduce 1 drms. of prepared chalk to a thin solution in distilled water, and add to it one fluid drms. of a strong solution of chloride of sodium (half that quantity of strong alum solution, or a little chloride of calcium may be better), and stir it well; then pour it quickly into the gelatin solution; and stir the whole thoroughly, boiling it until as thick as can be poured into a bottle with a large neck.

(3) Mix one fluid dram of alcohol, 95 per cent., into a fluid dram of sulphuric ether; pour into the gelatin and mix well. If too thick, thin it with acetic acid to suit, and add 6 or 7 drops of glycerin (C. P.); mix the whole thoroughly with a clean stick.

Do not insert the cork or shake the bottle with the ether and alcohol in it, or it will generate sufficient vapour to burst the glass or blow the cork out with half the cement. When it gets too thick in a warm room through evaporation, thin with alcoholic ether if you want it to dry faster; or with acetic acid to dry slowly.

Try it on glass, and if too brittle or liable to crack, add more glycerin, say two drops at a time, mixing well and repeat if necessary, until the cement will dry hard in from two to five hours; if at the end of two weeks (in a warm room) it will bear the test referred to above, it is sufficiently hard for filling up around balsam mounts, which have become hard and solid; for labels it has no equal.

Pour some of this cement into a 1 dram phial and colour it sufficiently with a strong solution of black 'Diamond' dye, and you have a beautiful black cement. With Diamond dyes you can give it any colour. In this case, the acid must be left out as it will precipitate the dyes and spoil the beauty of the cement. Alcohol, 50 per cent., will have to be used in lieu of the acid, and the mixture placed in warm water, if too cold or thick.

By mixing plenty of moist Chinese white with the colourless cement, and grinding it thoroughly in a mortar and placing it in a bottle with a sufficient quantity of glycerin to prevent cracking, you will have a beautiful and durable white cement. On a fair trial it will be found that these cements will have no equal for durability and tenacity on glass, and that they will not run into balsam mounts if the latter are sufficiently hard for any cement which dries quickly.

It will be necessary to give the rings made of these cements several coats of amber varnish or the best copal varnish, so as to resist moisture. I do not recommend these coloured cements for aqueous mounts lest they run in. Balsam, gelatin, or gum mounts, when neatly finished with the following transparent cements, are unequalled in beauty, and probably as durable as any; they never ruin any mounts by running in, and save the time consumed in ornamenting, which really adds no essential value to slides. Procure a good colourless amber, or best colourless copal varnish, and add a little white beeswax to one bottle of amber or of copal varnish or palmitate of alumina* instead of wax, and it will increase the tenacity and elasticity of the cements which are to be used for the body of the ring around moist or aqueous mounts, while the last, or last two coats, should be as hard as possible; they will adhere to softer coatings, while they might be too brittle to apply directly to the glass.

Good gold size has only one fault, it dries too slowly. The best copal varnishes are just as good, and dry in much less time. I abhor all fluid mounts, and therefore have no use for that miserable, brittle, crumbling white zinc cement which soon assumes a dirty mud colour.

When glass can be prepared to inclose an object in fluid and be as durable as the cells or tubes of spirit-levels, or bulbs of thermometers,

* Dissolve in oil of turpentine.

with a vacuum chamber (for expansion and contraction) at one side, and not interfere with objectives, then I may turn my attention to fluid media, but not till that is a success. For anhydrous cements I proceed as follows:—

(1) Give the balsam mounts a coat of good pale copal varnish as wide as the ring is to be. Good 'elastic gear varnish' is so tenacious and elastic that I have used polished steel tools (with only one coat of it) for over twenty years, it effectually protecting them from rust.

(2) Revolve the slide on the turntable and scrape or rub and polish the surface a little before applying the second coat; unless this is done the air or gloss will cause some trouble before the next coat will adhere to the surface. This operation requires care and skill.

(3) Build up or fill up the ring around the cover-glass, or, for a cell, use the same varnish with a little white beeswax dissolved with it, and thinned with turpentine or benzol if too thick. Put on thin coats and give each coat plenty of time to dry and harden, so that it may be scraped or polished; it requires very little friction on the surface to make the next coat adhere, I prefer a small sharp chisel, which can be made of a bradawl or selected from engravers' tools. I have sometimes used a small stick with its end properly dressed and dipped in cold water and pulverized pumice-stone, which is then washed away, but I like the chisel best.

(4) Apply one or two coats of ivory-black mixed with a little varnish; when dry and hard, polish with a scraper, cold water and pumice stone, or any suitable polishing material.

(5) Wash with cold water and a soft brush; wipe dry with soft chamois skin or linen rag.

(6) Apply an even coat of good amber or copal varnish. I find good copal varnish, called 'elastic gear varnish,' and used on carriage gearing, better than any gold size. It has to go through mud, rain, sand, the burning sun, expansion of heat and contraction of cold, on carriages and railroad passenger cars. The body of the ring should be hard, solid, tough, elastic, and above all, devoid of brittleness; it should be built up to the top of the cover-glass and finished with the best amber or copal varnish.

To make a colourless copal varnish, select the palest lumps of copal gum and crush them into small pieces, but do not pulverize when full of dirt; tie in a bag of fine muslin, and suspend in a wide-mouthed bottle of sulphuric ether, when the copal will gradually ooze out into the ether. When the gum has been digested, let the bag drain off and be thrown into another bottle of ether, which will remove all the available gum. It is a good plan to have plenty of the gum so that the liquid will form a varnish sufficiently thick. Then add oil of caraway or any slow drying essential oil, as oil of anise, or poppy, or sweet almonds, which are as colourless as possible in such small quantities; this will make the varnish dry more slowly and render it more elastic. When it dries properly, yet is too thick, add oil of rosemary or some such colourless essential oil that it may dry about as fast as it may be required. If it should dry too slowly add more ether and mix thoroughly.

Some of the essential oils, although colourless, have slightly

coloured my varnish, yet it is the most colourless I ever saw. It is elastic, dries hard and endures the test admirably, and is very tenacious; it is easily prepared in the way described."

(6) **Miscellaneous.**

Qualitative and Quantitative Microbiochemical Analysis.*—By microbiochemical analysis, M. W. Beycrinck means the employing of micro-organisms for demonstrating the presence and amount of certain substances of fixed composition, and the intention seems to be to obtain evidence of the nature of organic fluids from the extract of plants and from the products resulting from the action of ferments; and further to ascertain the constituents of very dilute solutions which are suitable for microbic growth.

For the qualitative analysis the auxanographic method† may be employed with advantage. The quantitative method depends, in principle, on the transference of the element or compound to the microbic substance and the quantitative determination of the latter by the enumeration of the colonies.

It would appear that this method is intended to determine the quantity of organic matter in dilute solutions and in drinking water by the growth of micro-organisms, and also to ascertain the total amount of nitrogen. It is stated that this method is extraordinarily sensitive, but the working details are not forthcoming, and without these a new method of procedure is difficult to follow.

Demonstration of Starch and Cellulose.‡—Prof. M. Hönig recommends the following process for the demonstration of the presence of starch and cellulose, and for the separation of these two substances from one another and from albuminoids. If a mixture of cellulose, starch, sugar, and albuminoids is heated with glycerin to 210° C., the cellulose undergoes no change, while the starch is transformed into a mixture of soluble starch and dextrine, which dissolves completely in hot water into a limpid fluid, and can be again precipitated by a mixture of 5 parts alcohol and 1 part ether, and the amount determined. The sugar and albuminoids are dissolved, and are not again precipitated by ether and alcohol. A practical method is described, founded on this reaction, for the determination of cellulose and starch in fibres.

The Leeuwenhoek Microscopical Club.§—The members of this private club, at Manchester, have published the records of their proceedings from 1867 to 1891. They have found that, for their purposes, six or eight persons form the most convenient numbers for effective consideration and discussion. The club has always used the Microscope as an accessory to investigation.

* Centralbl. f. Bakteriöl. u. Parasitenk., x. (1891) pp. 723-7.

† See this Journal, 1891, p. 800.

‡ Verhandl. Naturf. Ver. Brünn, xxix. 1890 (1891) pp. 23-5.

§ 'A Review of the Work of the Leeuwenhoek Microscopical Club, Manchester, 1867-91.'

PROCEEDINGS OF THE SOCIETY.

MEETING OF 17TH FEBRUARY, 1892, AT 20, HANOVER SQUARE, W.,
THE PRESIDENT (DR. R. BRAITHWAITE, F.L.S.) IN THE CHAIR.

The Minutes of the Annual Meeting of 20th January last were read and confirmed, and were signed by the President.

Prof. F. Jeffrey Bell said that he had, in accordance with the resolution passed at the last meeting, forwarded a copy of the message of condolence from the Society to the Prince of Wales, to General Sir Dighton Probyn, and had received from him the following letter of acknowledgment:—

“Sandringham, Norfolk.

“General Sir Dighton Probyn, Comptroller and Treasurer of
“the Household, is desired to convey to the Members of the Royal
“Microscopical Society the heartfelt thanks of the Prince and
“Princess of Wales for the Society’s kind Resolution expressing
“sympathy for their Royal Highnesses in their deep affliction.
“25th January, 1892.”

Prof. Bell said it would be noticed that Dr. Dallinger was again absent from the meeting, and in explanation of this he might mention that when, after the death of Mr. Mayall, Dr. Dallinger kindly undertook the duty of Secretary, he gave them to understand that he had already entered into a number of engagements which he would be unable to put off or alter, should they occur upon dates which coincided with the meetings of the Society. One of these engagements prevented him from being present with them that evening.

The List of Donations (exclusive of exchanges and reprints) received since the meeting of 16th December last was read, and the thanks of the Society were given to the donors.

Goring, C. R., and A. Pritchard, Natural History of . . . Objects for the Microscope. 96 pp., 5 pls. (Svo, London, 1829) ..	From Mr. Wynne E. Baxter.
Frey, H., Das Mikroskop. 4th ed., 372 pp., text illustrated. (Svo, Leipzig, 1871)	“
Pelletan, J., Les Diatomées. 3 pts. (Svo, Paris, 1888-89) ..	“
Curtis, W., Flora Londinensis. 3 vols. (fol., London, 1777-98)	{ Mr. J. Hopkinson, Pres. Herts Nat. Hist. Soc.
Jackson, B. D., A Flora of Hertfordshire. lviii. and 588 pp., 2 pls. (Svo, London, 1887)	Herts Nat. Hist. Soc.
Catalogue of Scientific Papers (1874-83). vol. ix. (4to, London, 1891)	Royal Society.
Woods, H., Catalogue of the Type Fossils in the Woodwardian Museum, Cambridge. xiv. and 180 pp. (Svo, Cambridge, 1891)	The Woodwardian Museum.

Prof. Bell called special attention to several of these donations, pointing out that the ‘Flora Londinensis,’ 1777, was a very valuable

and rare book, containing plates and descriptions of such plants as grew in the environs of London at that period; it would no doubt be very useful for reference and comparison, although so many of the species were no longer to be found in the places indicated that the other work presented by the same donor, the 'Flora of Hertfordshire,' would probably be of greater value to the modern collector. The volume presented to them by the Royal Society was one in continuation of the catalogue of scientific papers which were so valuable a help to all who were working up any particular scientific subject. The first six volumes of the series contained a list of all known papers published from 1800 to 1864; these were followed by two more which covered the period of ten years from 1864 to 1874, a work of great labour and cost; in the latter respect they received some assistance from the Government. Since that time, however, the Government had refused to help in the matter, and the work remained in abeyance until the Cambridge University Press took it up; the present volume was one of those intended to include the further period from 1874 to 1883. It seemed clear from the proportions which this book attained that the decade could not be comprised this time in two volumes, a fact which showed to what an extent scientific literature was increasing. Ho called attention to an important omission from the volume before them, the contents of the first nine volumes of the Transactions of the Zoological Society of France having been entirely neglected.

Mr. Watson exhibited and described a new vertical camera for photomicrography, designed upon the same lines as that used by Dr. Van Heurck.

The President inquired if it could also be used for drawing objects placed under the Microscope?

Mr. Watson thought it would be possible to utilize it for this purpose if something translucent were used to draw upon.

Prof. Bell said that Mr. Hermann, who wrote to the Society in December last describing the locality where *Volvox globator* was found in abundance, had sent another letter giving some further particulars, and had forwarded with the letter a bottle containing a quantity of this and other organisms.

The President then read his Annual Address, postponed from the last meeting under the special circumstances then mentioned. The subject chosen was the Impregnation and Modes of Reproduction in Ferns and Mosses; diagrams in illustration were exhibited and explained, and specimens were also shown under Microscopes in the room. A supply of duplicate specimens was also provided for distribution amongst the Fellows present.

The Rev. Edmund Carr was sure that he should express the feeling of the Society when he said they were very much obliged to the President for his very interesting and able address. It showed how extremely careful the observations must have been, and what pains must have been taken in the watching these things so as to be able to detect the

early progress of the different processes. With regard to the details, no doubt they would find them more easy to follow when they had the opportunity of reading them in print; the outline given was very clear, but the details would require to be carefully followed out in order to obtain a complete understanding of the subject. He had frequently grown ferns from their spores, and had witnessed the astonishment of those to whom the method of development had been explained; the details of the various processes could, however, only be watched by the most careful attention.

Prof. Groves had very great pleasure in seconding the vote of thanks to the President for his address. Many of those who were present had no doubt examined these objects under the Microscope; those who had not done so should certainly take the present opportunity of seeing them.

The vote of thanks having been carried by acclamation, was briefly acknowledged by the President, who then declared the business of the meeting to be concluded.

Mr. J. J. Vezey asked, however, to be permitted to make good an omission at the last meeting, by moving "That the best thanks of the Society be given to its Officers, and also to the Auditors and Scrutineers, for their services during the past year." The Fellows of the Society were so much indebted to them for the admirable way in which its affairs had been conducted, that it was only just that what had always been done in former years should not be omitted this year.

The President, without putting it to the meeting, declared the motion to be carried by acclamation.

Prof. Bell said it was usual on such occasions, when votes of thanks to the officers had been passed, for the junior Secretary to return thanks on behalf of his colleagues, and he felt quite sure that had Dr. Dallinger been with them that evening, he would have done so in a most satisfactory manner. In the absence of Dr. Dallinger he would content himself by saying that he was very grateful to them for the exceedingly kind way in which this vote had been received. With regard to the duties, it was undoubtedly a fact that the business of a society so large as theirs did require a certain amount of attention, but on the other hand, it also was a source of a certain amount of pleasure. If the position could be compared to that of a dog which had to lead along an infirm and blind beggar, it would not be one to be envied; but the spirited horse carrying a man or a woman across country was a different thing, and the secretary of a flourishing society like theirs could be compared to such a horse; so long as the Society continued in its present active condition there would be no difficulty in finding some one to perform the duties. But when one had performed them continuously for a lengthened period, and had to turn out of a warm house on a night like that on which they met, it was not unnatural that he should feel inclined to make a remark like that which was on one occasion uttered by Mr. Disraeli; who, having been called to attend with the members of the Lower House to witness a customary formality in the House of Lords, was carried off his legs in the unseemly rush; he is said to

have remarked with feeling, "This shall not happen again;" and so, when called out to face such weather as prevailed that evening, he himself was strongly impelled to say, "This shall not happen again." He only hoped that Dr. Dallinger, who had gone to fulfil an engagement in Wales, would not suffer from the effects of the very severe weather, especially after the two attacks of influenza which he had experienced within six weeks. Perhaps he might also be permitted to take the opportunity of returning thanks on behalf of another absent officer, Mr. Crisp, and in doing so he might say that if there was any officer of the Society to whom a vote of thanks should be given, that person was Mr. Crisp. If they took the statement of accounts for this year and compared it with that for the year before, they would notice that the expenses of the Journal, as there shown, appeared to be very much heavier. As a matter of fact, the actual cost of the Journal this year was not greater, although there appeared to be a difference of about 400*l*. Sums of 400*l*. had been paid by some one. That the heavy expense incurred on account of the Journal had been justified, was shown by the fact that the outside sale had gone up in a remarkable way, and it had become widely known as a publication of exceptional value. All this had been entirely done by Mr. Crisp, and at a cost to himself that would perhaps never be known; but, apart from the question of cost, all had been done with such a desire to improve the Journal and to serve the Society, that he thought a vote of thanks to the Treasurer should be taken separately, to show their sense of the very important services he had rendered.

The President said he could only bear witness to the correctness of what had been said by Prof. Bell as to the value of the Journal, and he did not hesitate to say that there was no other journal published by any other society which would stand comparison with it. This was not merely an opinion of his own, he had heard it so stated from Germany and the United States, where it was recognized as containing an account of the whole progress of biological science, and providing a means by which everybody could keep themselves posted up in whatever related to microscopy and biology. To Mr. Crisp alone belonged the credit of having carried on the Journal to its present state of efficiency.

The following Instruments, Objects, &c., were exhibited:—

The President:—Specimens illustrating the Annual Address.

Mr. M. J. Hermann:—*Volvox globator*, *Melicerta ringens*, &c.

Messrs. W. Watson:—Vertical Photomicrographic Apparatus.

New Fellows:—The following were elected *Ordinary* Fellows:—The Rev. N. Abraham, Mr. John Henry Bridge, Dr. Gottlieb Mark-tanner-Turneretscher, Messrs. Herbert Frederick Oddy, Henry Pye, and Charles Gabriel Seligmann.

MEETING OF 16TH MARCH, 1892, AT 20, HANOVER SQUARE, W.,
THE PRESIDENT (DR. BRAITHWAITE, F.L.S.) IN THE CHAIR.

The Minutes of the meeting of 17th February last were read and confirmed, and were signed by the President.

The following Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

Monograph of the Palæontographical Society, 1891 From
Mr. Crisp

Mr. G. C. Karop read a short paper descriptive of Messrs. Swift's new fine-adjustment for the substage of the Microscope, exhibited in the room, one complete revolution of which is equivalent to a vertical movement of the $1/125$ part of an inch.

The thanks of the meeting were, on the motion of the President, voted to Mr. Karop for his communication.

Mr. E. M. Nelson gave a résumé of the contents of two papers, the first of which was entitled "Virtual Images and Initial Magnifying Power," and the other "On Penetration in the Microscope."

The President expressed the thanks of the Society to Mr. Nelson for these papers. He was very glad to find that Mr. Nelson was making these matters very much more simple than was usually the case, it being too often assumed that the Fellows of a scientific society were able to understand at once what was really only clear to those whose time and attention had been specially devoted to such subjects.

Dr. Dallinger said they had received from Prof. Czapski an important communication "On the Calculable Limit of Microscopic Vision." Considering its technical character, it would be unwise to read the whole of this paper at the meeting, but he might mention that its purpose was to show why it was that great numerical aperture was of such high value in the determination of minute structure, and to inquire whether—seeing that a numerical aperture of 1.60 was so utterly unavailable in the case of living objects or of such as did not admit of being put into media of sufficiently high refractive index—there was any method of making these high numerical apertures available for such objects? The author's attention had turned in this inquiry towards the value of monochromatic light for such a purpose—not simply coloured light, but that which was in a strict sense purely monochromatic, such as was recently shown at one of their meetings by Mr. Nelson—and the latter part of his paper went to show that by using blue rays of such light with large apertures, it was possible to increase the aperture so as to obtain the relatively great advantage which would result from a difference between 1.40 and 1.75. The paper was in itself so thoroughly valuable, and the matter was worked out in a way that was

so clear and convincing, that it was well worth the attention of the practical microscopist.

Mr. Crisp thought it should be pointed out that the broad fact dealt with in this paper was one which had long ago been explained—certainly ten years ago—though perhaps it had not been worked out in the same manner.

Dr. Dallinger said he had himself worked it out some time ago, obtaining as a result the difference between 1.40 and 1.70, which came remarkably near to that mentioned in the paper.

Mr. Crisp said that the aperture table, which was printed with every number of the Journal, gave them the difference in resolving power between white light and monochromatic blue light with objectives of various apertures.

Prof. Bell called attention to the fact that in the December number of the Journal there was an abstract of what appeared to be the same paper as that just read; the account ran to something like five pages of the Journal, and if it really referred to the same thing, they could not of course publish it now in the Journal, after its previous publication elsewhere.

Dr. Dallinger said that the subject was no doubt the same so far as the main facts were concerned, and it was also one which was not new to English observers, though the results were, in the paper before them, more completely worked out than they had hitherto been, and were put before them much more simply.

Prof. Bell said they also had a paper by Mr. H. L. Brevoort entitled "Observations on the Brownian Movement"; after giving a brief outline of its contents he pointed out that whilst the general conclusion arrived at by the author was that light had some influence in the matter, he did not seem to have taken any precautions as to temperature, so that he had not really eliminated from his calculations an element which was usually considered to be an active agent in the production of the observed phenomena.

Dr. Dallinger read a letter received from the Hon. J. G. P. Vereker, taking notice of some points raised during the discussion of his paper "On the Resolution of Podura Scales" read at the December meeting of the Society.

Dr. A. C. Mercer then read his paper on Photomicrography as illustrated by a collection of 73 lantern slides exhibited upon the screen by Messrs. Nelson and C. L. Curties. Among the slides exhibited was a group which illustrated a mooted point in *Podura* scale structure, the author showing that the so-called featherlets on *Podura* scales are only inflations of the membrane. A number of slides also proved the value of the Microscope as a means of detection in cases of forgery, or when alterations were alleged to have been made in promissory notes. A further group of slides was devoted to the illustration of photomicrographic apparatus.

The President proposed a cordial vote of thanks to Dr. Mercer for what he regarded as the finest example of what could be done by means of photomicrography; the exhibition of these slides had been a matter of interest to all who had seen them.

Prof. Bell said that the Council had been taking into consideration what arrangements could be made for holding the usual *Conversazione*, but they had found it impossible to secure an evening earlier than one in May. Their experience had, however, been that meetings of that kind held in May, when the evenings were getting light, were always very poorly attended, and on that account they had at present hesitated to make a definite arrangement. The matter would, however, receive their further attention, but if it was ultimately found necessary to abandon a meeting in May, he trusted that it would be found that neither the meeting nor the Fellows of the Society would suffer any loss from a postponement.

The following Instruments, Objects, &c., were exhibited:—

Mr. G. C. Karop:—Swift's new Fine-adjustment to Substage.

Dr. A. C. Mercer:—Lantern Exhibition of Photomicrographs and Apparatus.

New Fellows:—The following were elected *Ordinary* Fellows:—
Mr. C. J. Pound, Dr. Lloyd Tuckey, and Mr. E. T. Lawley York.

The Journal is issued on the third Wednesday of
February, April, June, August, October, and December.

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JUNE.

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Price 5s.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY;

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS,

AND A SUMMARY OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.

Edited by

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FELLOWS OF THE SOCIETY.



WILLIAMS & NORGATE,
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APERTURE TABLE.

Numerical Aperture. ($n \sin u = a$.)	Corresponding Angle (2 u) for			Limit of Resolving Power, in Lines to an Inch.			Illuminating Power. (a^2 .)	Penetrating Power ($\frac{1}{a}$)
	Air ($n = 1.00$.)	Water ($n = 1.33$.)	Homogeneous Immersion ($n = 1.52$.)	White Light. ($\lambda = 0.5269 \mu$, Line E.)	Monochromatic (Blue) Light. ($\lambda = 0.4861 \mu$, Line F.)	Photography. ($\lambda = 0.4000 \mu$, Near Line h.)		
1.52	..	..	180° 0'	146,543	158,845	193,037	2.310	.658
1.51	..	..	166° 51'	145,579	157,800	191,767	2.280	.662
1.50	..	..	161° 23'	144,615	156,755	190,497	2.250	.667
1.49	..	..	157° 12'	143,651	155,710	189,227	2.220	.671
1.48	..	..	153° 39'	142,687	154,665	187,957	2.190	.676
1.47	..	..	150° 32'	141,723	153,620	186,687	2.161	.680
1.46	..	..	147° 42'	140,759	152,575	185,417	2.132	.685
1.45	..	..	145° 6'	139,795	151,530	184,147	2.103	.690
1.44	..	..	142° 39'	138,830	150,485	182,877	2.074	.694
1.43	..	..	140° 22'	137,866	149,440	181,607	2.045	.694
1.42	..	..	138° 12'	136,902	148,395	180,337	2.016	.709
1.41	..	..	136° 8'	135,938	147,350	179,067	1.988	.709
1.40	..	..	134° 10'	134,974	146,305	177,797	1.960	.714
1.39	..	..	132° 16'	134,010	145,260	176,527	1.932	.719
1.38	..	..	130° 26'	133,046	144,215	175,257	1.904	.725
1.37	..	..	128° 40'	132,082	143,170	173,987	1.877	.729
1.36	..	..	126° 58'	131,118	142,125	172,717	1.850	.735
1.35	..	..	125° 18'	130,154	141,080	171,447	1.823	.741
1.34	..	..	123° 40'	129,189	140,035	170,177	1.796	.746
1.33	..	180° 0'	122° 6'	128,225	138,989	168,907	1.769	.752
1.32	..	165° 56'	120° 33'	127,261	137,944	167,637	1.742	.758
1.30	..	155° 38'	117° 35'	125,333	135,854	165,097	1.690	.769
1.28	..	148° 42'	114° 44'	123,405	133,764	162,557	1.638	.781
1.26	..	142° 39'	111° 59'	121,477	131,674	160,017	1.588	.794
1.24	..	137° 36'	109° 20'	119,548	129,584	157,477	1.538	.806
1.22	..	133° 4'	106° 45'	117,620	127,494	154,937	1.488	.820
1.20	..	128° 55'	104° 15'	115,692	125,404	152,397	1.440	.833
1.18	..	125° 3'	101° 50'	113,764	123,314	149,857	1.392	.847
1.16	..	121° 26'	99° 29'	111,835	121,224	147,317	1.346	.862
1.14	..	118° 0'	97° 11'	109,907	119,134	144,777	1.300	.877
1.12	..	114° 44'	94° 55'	107,979	117,044	142,237	1.254	.893
1.10	..	111° 36'	92° 43'	106,051	114,954	139,698	1.210	.909
1.08	..	108° 36'	90° 34'	104,123	112,864	137,158	1.166	.926
1.06	..	105° 42'	88° 27'	102,195	110,774	134,618	1.124	.941
1.04	..	102° 53'	86° 21'	100,266	108,684	132,078	1.082	.963
1.02	..	100° 10'	84° 18'	98,338	106,593	129,538	1.040	.980
1.00	180° 0'	97° 31'	82° 17'	96,410	104,503	126,998	1.000	1.000
0.98	157° 2'	94° 56'	80° 17'	94,482	102,413	124,458	.960	1.020
0.96	147° 29'	92° 24'	78° 20'	92,554	100,323	121,918	.922	1.042
0.94	140° 6'	89° 56'	76° 24'	90,625	98,223	119,378	.884	1.064
0.92	133° 51'	87° 32'	74° 30'	88,697	96,143	116,838	.846	1.087
0.90	128° 19'	85° 10'	72° 36'	86,769	94,053	114,298	.810	1.111
0.88	123° 17'	82° 51'	70° 44'	84,841	91,963	111,758	.774	1.136
0.86	118° 38'	80° 34'	68° 54'	82,913	89,873	109,218	.740	1.163
0.84	114° 17'	78° 20'	67° 6'	80,984	87,783	106,678	.706	1.190
0.82	110° 10'	76° 8'	65° 18'	79,056	85,693	104,138	.672	1.220
0.80	106° 16'	73° 58'	63° 31'	77,128	83,603	101,598	.640	1.250
0.78	102° 31'	71° 49'	61° 45'	75,200	81,513	99,058	.608	1.282
0.76	98° 56'	69° 42'	60° 0'	73,272	79,423	96,518	.578	1.310
0.74	95° 28'	67° 37'	58° 16'	71,343	77,333	93,979	.548	1.351
0.72	92° 6'	65° 32'	56° 32'	69,415	75,242	91,439	.518	1.388
0.70	88° 51'	63° 31'	54° 50'	67,487	73,152	88,899	.490	1.426
0.68	85° 41'	61° 30'	53° 9'	65,559	71,062	86,359	.462	1.471
0.66	82° 36'	59° 30'	51° 28'	63,631	68,972	83,819	.436	1.511
0.64	79° 36'	57° 31'	49° 48'	61,702	66,882	81,279	.410	1.562
0.62	76° 38'	55° 34'	48° 9'	59,774	64,792	78,739	.384	1.614
0.60	73° 44'	53° 38'	46° 30'	57,846	62,702	76,199	.360	1.667
0.58	70° 54'	51° 42'	44° 51'	55,918	60,612	73,659	.336	1.724
0.56	68° 6'	49° 48'	43° 14'	53,990	58,522	71,119	.314	1.786
0.54	65° 22'	47° 54'	41° 37'	52,061	56,432	68,579	.292	1.852
0.52	62° 40'	46° 2'	40° 0'	50,133	54,342	66,039	.270	1.922
0.50	60° 0'	44° 10'	38° 24'	48,205	52,252	63,499	.250	2.000
0.45	53° 30'	39° 33'	34° 27'	43,385	47,026	57,149	.203	2.222
0.40	47° 9'	35° 0'	30° 31'	38,564	41,801	50,799	.160	2.500
0.35	40° 58'	30° 30'	26° 38'	33,744	36,576	44,449	.123	2.857
0.30	34° 56'	26° 4'	22° 46'	28,923	31,351	38,099	.090	3.333
0.25	28° 53'	21° 40'	18° 56'	24,103	26,126	31,749	.063	4.000
0.20	23° 4'	17° 18'	15° 7'	19,282	20,901	25,400	.040	5.000
0.15	17° 14'	12° 58'	11° 19'	14,462	15,676	19,050	.023	6.667
0.10	11° 29'	8° 38'	7° 34'	9,641	10,450	12,700	.010	10.000
0.05	5° 44'	4° 18'	3° 46'	4,821	5,252	6,350	.003	20.000

COMPARISON OF THE FAHRENHEIT AND CENTIGRADE THERMOMETERS.

Fahr.	Centigr.	Fahr.	Centigr.	Fahr.	Centigr.	Fahr.	Centigr.	Fahr.	Centigr.
°	°	°	°	°	°	°	°	°	°
212	100	158	70	104	40	50	10	- 4	- 20
210·2	99	156·2	69	102·2	39	48·2	9	- 5·8	- 21
210	98·89	156	68·89	102	38·89	48	8·89	- 6	- 21·11
208·4	98	154·4	68	100·4	38	46·4	8	- 7·6	- 22
208	97·78	154	67·78	100	37·78	46	7·78	- 8	- 22·22
206·6	97	152·6	67	98·6	37	44·6	7	- 9·4	- 23
206	96·67	152	66·67	98	36·67	44	6·67	- 10	- 23·33
204·8	96	150·8	66	96·8	36	42·8	6	- 11·2	- 24
204	95·56	150	65·56	96	35·56	42	5·56	- 12	- 24·44
203	95	149	65	95	35	41	5	- 13	- 25
202	94·44	148	64·44	94	34·44	40	4·44	- 14	- 25·56
201·2	94	147·2	64	93·2	34	39·2	4	- 14·8	- 26
200	93·33	146	63·33	92	33·33	38	3·33	- 16	- 26·67
199·4	93	145·4	63	91·4	33	37·4	3	- 16·6	- 27
198	92·22	144	62·22	90	32·22	36	2·22	- 18	- 27·78
197·6	92	143·6	62	89·6	32	35·6	2	- 18·4	- 28
196	91·11	142	61·11	88	31·11	34	1·11	- 20	- 28·89
195·8	91	141·8	61	87·8	31	33·8	1	- 20·2	- 29
194	90	140	60	86	30	32	0	- 22	- 30
192·2	89	138·2	59	84·2	29	30·2	- 1	- 23·8	- 31
192	88·89	138	58·89	84	28·89	30	- 1·11	- 24	- 31·11
190·4	88	136·4	58	82·4	28	28·4	- 2	- 25·6	- 32
190	87·78	136	57·78	82	27·78	28	- 2·22	- 26	- 32·22
188·6	87	134·6	57	80·6	27	26·6	- 3	- 27·4	- 33
188	86·67	134	56·67	80	26·67	26	- 3·33	- 28	- 33·33
186·8	86	132·8	56	78·8	26	24·8	- 4	- 29·2	- 34
186	85·56	132	55·56	78	25·56	24	- 4·44	- 30	- 34·44
185	85	131	55	77	25	23	- 5	- 31	- 35
184	84·44	130	54·44	76	24·44	22	- 5·56	- 32	- 35·56
183·2	84	129·2	54	75·2	24	21·2	- 6	- 32·8	- 36
182	83·33	128	53·33	74	23·33	20	- 6·67	- 34	- 36·67
181·4	83	127·4	53	73·4	23	19·4	- 7	- 34·6	- 37
180	82·22	126	52·22	72	22·22	18	- 7·78	- 36	- 37·78
179·6	82	125·6	52	71·6	22	17·6	- 8	- 36·4	- 38
178	81·11	124	51·11	70	21·11	16	- 8·89	- 38	- 38·89
177·8	81	123·8	51	69·8	21	15·8	- 9	- 38·2	- 39
176	80	122	50	68·2	20	14	- 10	- 40	- 40
174·2	79	120·2	49	66	19	12·2	- 11	- 41·80	- 41
174	78·89	120	48·89	66·4	18·89	12	- 11·11	- 42	- 41·11
172·4	78	118·4	48	64	18	10·4	- 12	- 43·60	- 42
172	77·78	118	47·78	64·6	17·78	10	- 12·22	- 44	- 42·22
170·6	77	116·6	47	62	17	8·6	- 13	- 45·40	- 43
170	76·67	116	46·67	62·8	16·67	8	- 13·33	- 46	- 43·33
168·8	76	114·8	46	60	16	6·8	- 14	- 47·20	- 44
168	75·56	114	45·56	60	15·56	6	- 14·44	- 48	- 44·44
167	75	113	45	59	15	5	- 15	- 49	- 45
166	74·44	112	44·44	58	14·44	4	- 15·56	- 50	- 45·56
165·2	74	111·2	44	57·2	14	3·2	- 16	- 50·80	- 46
164	73·33	110	43·33	56	13·33	2	- 16·67	- 52	- 46·67
163·4	73	109·4	43	55·4	13	1·4	- 17	- 52·60	- 47
162	72·22	108	42·22	54	12·22	0	- 17·78	- 54	- 47·78
161·6	72	107·6	42	53·6	12	- 0·4	- 18	- 54·40	- 48
160	71·11	106	41·11	52	11·11	- 2	- 18·89	- 56	- 48·89
159·8	71	105·8	41	51·8	11	- 2·2	- 19	- 56·20	- 49
								- 58	- 50



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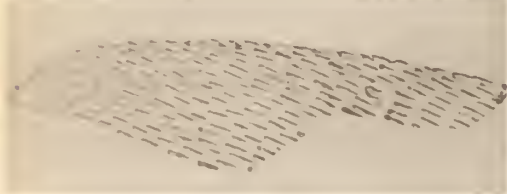




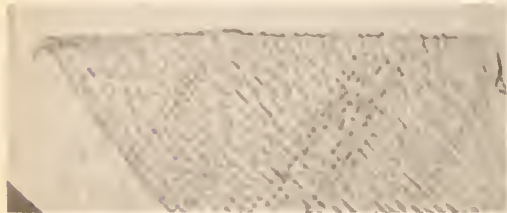
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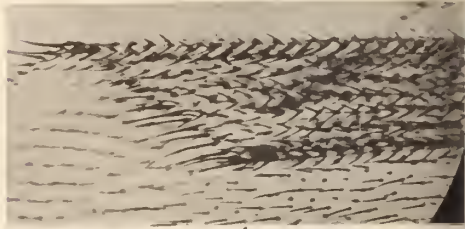
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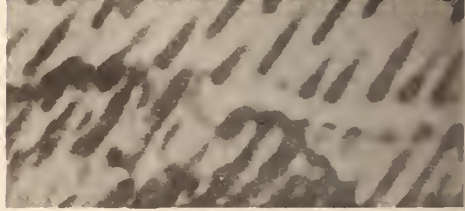
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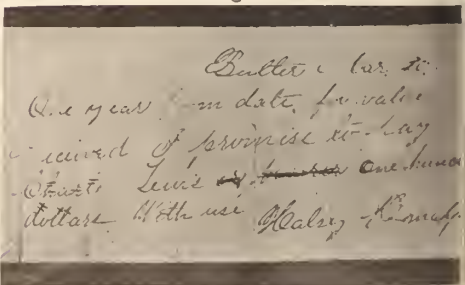
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JOURNAL OF THE ROYAL MICROSCOPICAL SOCIETY.

JUNE 1892.

TRANSACTIONS OF THE SOCIETY.

VI.—*On a Series of Lantern Slides: Photomicrographs and Photographs of Photomicrographic Apparatus.*

By A. CLIFFORD MERCER, M.D., F.R.M.S.

(Exhibited 16th March, 1892.)

PLATE IV.

OF the seventy-three slides exhibited, a few only will receive attention in this paper. These will be considered under the three headings of Photomicrographs of Natural Objects, Photomicrographs of Printed and Written Matters, and Photographs of Photomicrographic Apparatus. Before considering particular slides it may be wise to say a few words of a general character about the objectives and illumination.

The objectives used were a 1/25-in. by H. R. Spencer, various objectives by Powell and Lealand, a 1/8-in., and a 1½-in. by W. Wales. In no instance was an apochromatic used, and in only one instance an eye-piece. The Spencer 1/25-in. is peculiar in having a collar adjustment for water, glycerin, and homogeneous immersion, with or without a cover-glass. The Wales objectives are corrected spherically for the violet ray. The violet image is therefore somewhat superior to the visual, with which, however, it is coincident; and the fields of these photo-objectives* are unusually flat.

The light, with two exceptions, was from the edge of a lamp-

EXPLANATION OF PLATE IV.

- Fig. 1.—The spear-shaped ends of hairs from the “carpet-bug.”
” 2.—A portion of a cricket’s tongue.
” 3.—Sphagnum leaves.
” 4.—A folded wing from a marsh-fly.
” 5.—A fragment of a *Podura* scale.
” 6.—A rent in a *Podura* scale.
” 7.—A folded *Podura* scale.
” 8.—A letter *J* from a forgery.
” 9.—A promissory note.
” 10.—The letter *a* in “bearer” of the promissory note.

* Trans. Roy. Micr. Soc., n.s., xv. (1867) p. 254; and Monthly Microscopical Journal, vi. (1871) p. 172.

flame, passed through a bull's-eye, a cell * containing a solution of ammonio-sulphate of copper, and substage condensers of varying foci and apertures. The exceptions were the use of sunlight in photomicrographing two *Amphipleuræ*.

Incidentally, the improvement gained by cementing the cover-glass to the lantern slide proper is shown in the photograph of a promissory note. The dammar cement has not held in certain parts where the picture is not so bright as in others where the cement has held and where, therefore, there are but two, instead of four, reflecting surfaces.

Photomicrographs of Natural Objects.

In slide 4, a dog's flea, the details in the non-actinic parts are obscure or wanting, because the negative was taken on an ordinary gelatino-bromide plate.

In slide 5, the same object, from a negative on a Carbutt orthochromatic plate, the details in the yellow portions are clearer; and in the red are now seen details which could not be seen at all in the former slide.

In slide 7 (plate IV. fig. 1) are seen the lance-shaped ends of the long hairs of the American "carpet-bug," the larva of *Anthrenus scrophulariæ*, a comparatively recent and not welcome importation from this side of the Atlantic. A change in habitat has increased its voracity for all kinds of household articles more or less made up of fur, wool, or other animal fibres, much to the dread and trouble of every housewife in the country of its adoption. Slide 15 (plate IV. fig. 2) shows a portion of a cricket's tongue; a sharp and flat field result with the Wales 1/8-in. photo-objective. Slide 73 (plate IV. fig. 3) is a negative of *Sphagnum* leaves, giving the effect of paraboloid illumination.

Nine slides illustrate a mooted point in *Podura* scale structure. Three slides show broken or folded hairy wings, or skin, from a marsh-fly and a caterpillar, with hairs projecting into the adjacent clear field from the broken or folded edge, and present an appearance (plate IV. fig. 4) similar to that which a broken or folded *Podura* scale might be expected to show were it covered with "spines," or "featherlets," attached at one end and to some extent free at the other. Mr. C. Henry Kain, of Philadelphia, has been skilful enough and kind enough to break or fold for me several *Podura* scales, of which the following four slides are photomicrographs. In slide 46 (plate IV. fig. 5) is seen a fragment of a *Podura* scale, showing the edge of a transverse and oblique fracture. Nothing like a spine or featherlet projects from the edge, nor are there any portions of spines or featherlets free in the adjacent field. On the other hand, the

* Trans. Roy. Micr. Soc., n.s., xv. (1867) p. 253 *et seq.*; and Monthly Microscopical Journal, viii. (1872) p. 186.

"exclamation marks" are broken off in exact line with the general line of fracture, as though they were throughout their length part of the substance of the scale. Slide 47 (plate IV. fig. 6) is an enlargement from a negative showing a rent in a *Podura* scale passing in from one edge nearly transversely across some exclamation marks. In several instances the broad part of the mark is undisturbed on one edge of the rent, and the corresponding point undisturbed on the other. In slide 48 the exclamation marks are in one part seen bent, with a bend in the general substance of the scale. In another part is an appearance suggesting that a transverse section of a scale would have a corrugated outline. In slide 49 (plate IV. fig. 7) another bent *Podura* scale gives a still more marked hint of corrugation, and leads us to suppose that the convexities of corrugation at one surface would correspond with the exclamation marks. Will not some delicate worker stain *Podura* scales, cut sections of them by some imbedding process, and establish or overthrow this hypothesis?

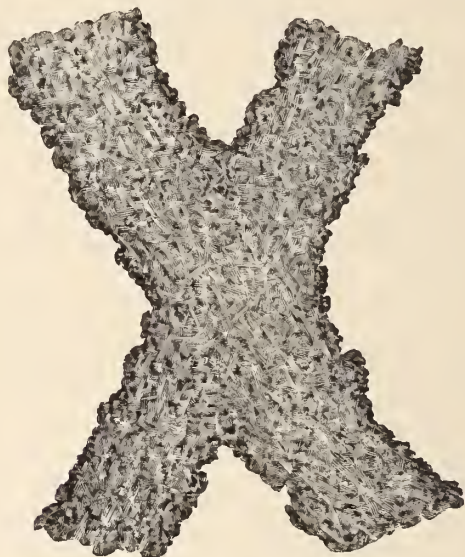
Photomicrographs of Printed and Written Matters.

The irregular distribution of printer's ink on the fibrous surface of an ordinary newspaper is seen in slide 20. The microscopic character of the engraver's hatch and stipple in a United States two cent postage stamp is seen in slide 22.

Slide 23 (fig. 34) is a photomicrograph of a quickly-made pen-and-ink crossing, showing the free flowing of the ink of one line into that of the other, a mingling of the inks. All trace of borders to either line is lost at the crossing. The ink of the first line must have been quite wet when the crossing stroke was made. Had the first line been partially or quite dry, the ink of the second line would have overflowed to the first but partially or not at all. Of the truth of these statements I have satisfied myself by the examination of several thousand pen-and-ink crossings, made under greatly varying conditions as to pen, ink, paper, and interval of time between the two strokes. If the first ink be perfectly dry, the second ink is not more likely to overflow its borders at the crossing than elsewhere on the surface of the paper. Slide 24 (plate IV. fig. 8) shows the greater portion of a letter *J* from a forged document. This document was first written in pencil and then gone over with a bolder hand in ink, as was demonstrated by the Microscope finding bits of graphite here and there where the ink had failed to wholly cover the pencil lines. The forger then shaded certain letters he had missed shading, one of which was this *J* in his father's signature. As the *J* was dry when the shading was added, the ink of the shading stroke did not overflow to the underlying line. The shading stroke is as distinct as if it had been made on a fresh surface of the paper. A special reason for the forger not originally shading the *J* was that he habitually penned a *J* in a direction reverse to that habitual with his father.

Slide 25 (plate IV. fig. 9) is a photograph of a promissory note made by "Halsey Knapp" payable to "Charles Lewis, or bearer," with pen-marks drawn across the words "or bearer" indicating erasure. This note, dated Butler, N.Y., March 20, 1884, endorsed by Eli Knapp, was in the possession of the maker, Halsey Knapp,

FIG. 34.



during about nine months before it was taken to Charles Lewis living in another part of New York State. The note then remained in the hands of Charles Lewis for three years. At the end of the three years, Halsey Knapp being unable to meet the obligation, Charles Lewis brought an action in the supreme court of New York State against the endorser, Eli Knapp, to recover the amount of the note. The endorser had refused to redeem the note because he had not received a notice of protest to which he claimed he had been entitled. He claimed the note had been altered, the words "or bearer" erased by Mr. Lewis so as to make it appear that he had not been entitled to a notice of protest. Mr. Lewis, on the other hand, claimed that the erasure of the words "or bearer" was made by the maker, Halsey Knapp, and was a part of the original note. (In New York State an endorser of a note is entitled to a notice of protest in the case of a negotiable note, made negotiable by being drawn payable to "a bearer," and not in the case of a non-negotiable note.) The chemical laboratory of Cornell University could only go so far as to say that the ink of the note as a whole and that of the lines of erasure were

chemically the same. The important question was "When was the erasure made?" The holder, Mr. Lewis, was almost alone in saying the erasure was made when the note was drawn. Finally, the Microscope was brought into service.

Slide 26 (plate IV. fig. 10) shows in part what the Microscope revealed. The letter *a* of "bearer" and a portion of the lines of erasure are seen. The ink of the cross-lines has partially overflowed to the lines of the letter. Therefore, the erasure was made before the words "or bearer" were quite dry; and as the note did not reach Mr. Lewis for nine months after it was made, the erasure could not have been made by Mr. Lewis. But even this result did not quite satisfy the plaintiff's counsel, Mr. J. T. Newman, of Ithaca, N.Y. He wished to have the time of the erasure more definitely fixed. The Microscope succeeded at last in satisfying the counsel, by approximately fixing the time. This was done in the following manner. It was noted that in the erasure of the words "or bearer" the cross-lines gave a possibility of 52 overflowings and that there were actually 28 overflowings to a degree as great as, or greater than, a certain overflowing taken as a standard unit; that is to say, the actual overflowing was 54 per cent. of the possibility. The words "or bearer" were then repeatedly written and crossed at different intervals of time afterward. A series of such erasures with an interval of five hours gave .0 per cent. of overflowing. A series with an interval of one hour and a series with an interval of fifteen minutes both gave .0 per cent. of overflowing. A series with an interval of five minutes gave .8 per cent. of overflowing. A series with an interval of three minutes gave .4 per cent. of overflowing. A series with an interval of two minutes gave 1.1 per cent. of overflowing. A series with an interval of one minute gave 17 per cent. of overflowing. A series with an interval of 1/2 minute gave 35 per cent. of overflowing. A series with an interval of only a few seconds gave 90 per cent. of overflowing. As the supposed conditions under which the note had been made were imitated in getting the foregoing percentages and as the erasure in the note had given 54 per cent. of overflowing, it was reasonable to believe the erasure was made approximately within half a minute after the words "or bearer" were written, an interval of time shown by experiment to be little more than enough for writing the remainder of the note and signing it. The Microscope, then, was able to show that the erasure was not only made before the words "or bearer" were dry, but at the latest almost immediately after the note was signed. Slides 28 and 29 are photomicrographs of experimental cross-lines over *l* of "Charles" and *d* of "dollars" in the note (plate IV. fig. 9). The ink of the cross-lines has not overflowed to the lines of the letters.

The case was argued before a referee, J. N. Hammond, Esq., in Seneca Falls, N.Y., June 25th, 1887, and, notwithstanding the weight of other evidence favoured the defendant, the Microscope in the court,

aided by bromide paper enlargements from photomicrographic negatives, turned the scales and won a decision in favour of the plaintiff.

Photographs of Photomicrographic Apparatus.

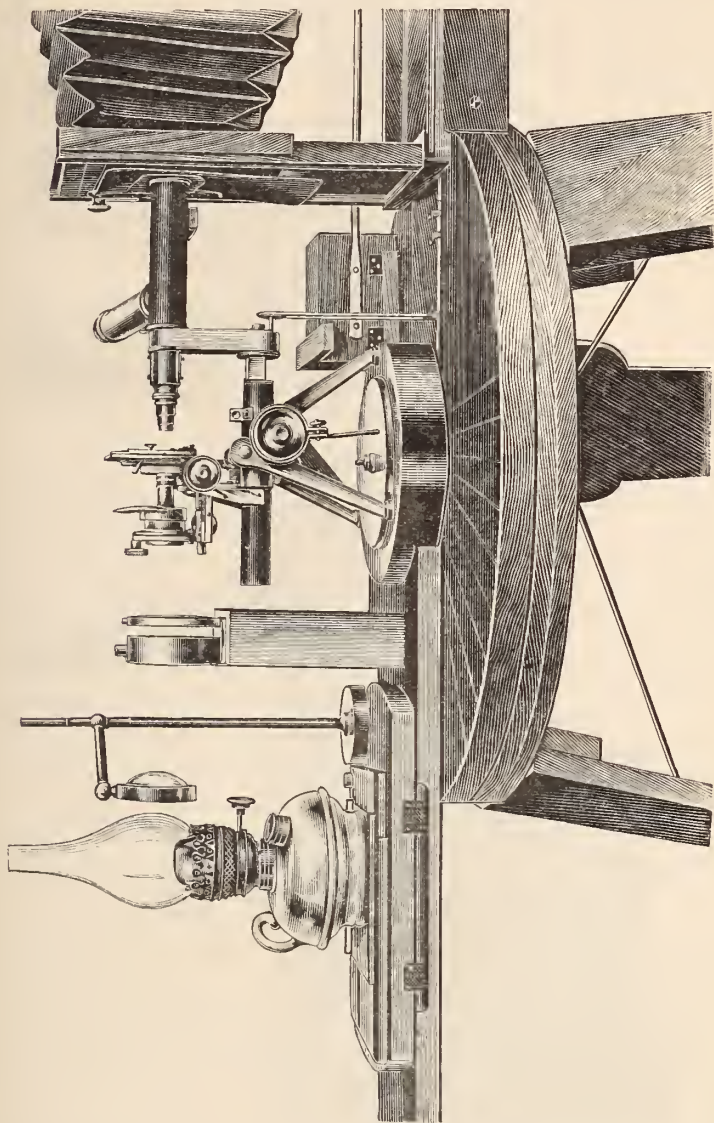
In the fifth edition (1880) of Dr. Beale's 'How to Work with the Microscope,' p. 309, will be found the woodcut seen in slide 50, representing my wet plate apparatus as it stood at that time. The old support, consisting of a camera bed about six feet long with a single leg at one end and a round table-top expansion with three legs at the other, is also the support of my present apparatus. The sliding-box camera has been replaced by a bellows camera taking plates up to 8 by 10 in. The special Microscope has been replaced by a Powell and Lealand No. 3 stand, which with accessories rests on the table-top expansion.

Slides 51 and 52 (figs. 35 and 36) show the general arrangement of the apparatus on the table-top expansion. The camera front moves freely toward the Microscope, a hole in the front board receiving the eye end of the horizontal Microscope-tube until the board comes in contact with a black card fitting light-tight about the tube. The camera front is easily removed, so the eye can glance through the Microscope without changing the position of the instrument, or, so the Microscope and all the apparatus for artificial lighting can be turned to one side for arrangement and then turned back again. That the latter may be done, the Microscope and lighting apparatus stand upon a board which revolves about a vertical axis passing through the object on the stage. A similar convenience is familiar to you in Mr. Pringle's apparatus.* I prefer, however, to have the Microscope and camera constantly connected and to use a secondary horizontal tube, at a convenient height for the eye when sitting, projecting at an angle of 90° from one side of the ordinary axial tube. A plane mirror silvered and polished on its objective surface and set at an angle of 45° reflects the picture forming rays from the axial into the side tube. The eye-piece of the side tube is 10 in. (central measurement through the two tubes) from the objective. When the position of the object and its illumination are satisfactory, the mirror is withdrawn wholly into the side tube, allowing the objective to project an image into the camera. The axial tube, in addition to having its inner surface well blackened, contains a sufficient number of diaphragms to thoroughly prevent internal reflection. When an eye-piece is not used in the axial tube, a dummy eye-piece, with diaphragms, but without lenses, is inserted to prevent reflection from the interior of the eye end of the tube, where it is always more or less bright. I have found this dummy eye-piece a matter of importance. I believe the

* This Journal, 1890, pp. 513-7, 666.

bright surface it should cover has been quite commonly neglected and has been the cause of many poor results in photomicrography.

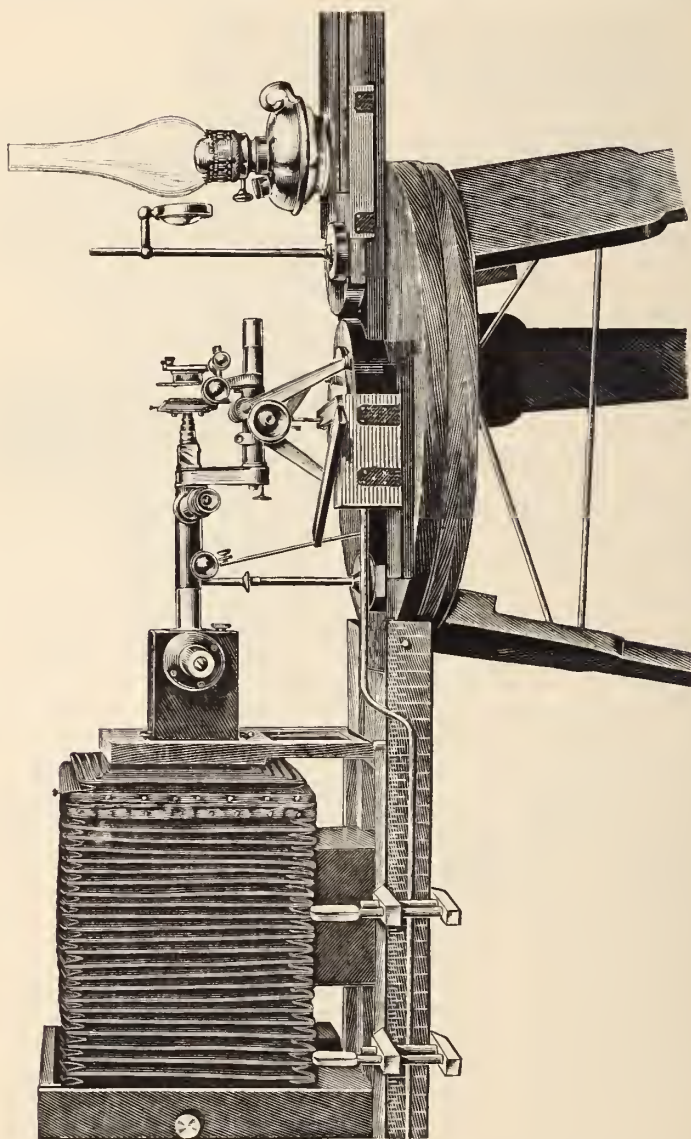
FIG. 35.



In slide 52 (fig. 36) is seen a block of heavy wood which slides in a direction parallel with the axis of the Microscope, without lateral

movement and on cloth bearings, between two cleats of hard wood screwed to the table-top expansion. The block is moved back and

FIG. 36.



forth by a brass rod supported all along one side of the camera bed. From the top of the block projects towards the Microscope a small bar

of wood with a screw-eye at its free end. A lever-rod fastened by a ring and milled-headed screw to the coarse-adjustment wheel drops into the screw-eye. By this simple contrivance coarse focusing can be done on the ground glass at any distance from the Microscope—by moving the long brass rod in its support, and so moving the block and lever. From about the fine-adjustment wheel (fig. 35), an endless cord passes down and about a pulley-wheel, actuated by a brass rod, supported all along under the camera bed, so that fine focusing can be done at any distance from the Microscope. Coarse focusing is done on the ground-glass, fine focusing by a focusing lens held against a piece of polished plate-glass substituted for the ground-glass.

Projecting from the sliding block is a second bar ending with a screw-eye which receives a lever from the rack and pinion moving the draw-tube.

Either lever is quickly fastened or loosened by a thumb-screw closing or opening the ring about the milled wheel. First one lever alone, or the other, is used; never the two together. The draw-tube lever is used when by the Woodward method* the back focus of an objective is extended by an achromatic meniscus screwed into the objective end of the draw-tube. It seems to be almost forgotten that Dr. Woodward produced his famous photomicrographs by this method. The method, briefly, is first to arrange the object and illumination, to adjust the objective-collar most carefully for the 10-in. distance, then to remove the eye-piece, to screw the meniscus into the objective end of the draw-tube, and, finally, to adjust the draw-tube until the meniscus is at the right distance from the back of the objective to extend the focus to the ground glass, the objective meantime remaining undisturbed in its best condition. No other method gave as good results until the apochromatic method was introduced. In the apochromatic method, however, the objective is not left undisturbed, and the projecting eye-piece has two lenses with four reflecting surfaces. If it were practicable to make a compensating concave with only two reflecting surfaces, analogous to the Woodward meniscus, to be used instead of the projecting eye-piece, a so modified apochromatic method would be more rapid and might perhaps give even more brilliant results.

The lamp, edge of the flame on, and bull's-eye are carefully centered on sliding boards, so as to be able conveniently to use Mr. Nelson's method of illumination.† The light (fig. 35) passes through an alum or water cell, and an ammonio-sulphate of copper cell—seen between the bull's-eye and substage condenser—to eliminate most of the heat-rays, to give visually monochromatic light, and to make the visual image approximately the same as the actinic image. I believe by using the blue cell I have been able to approximately focus the actinic rays; for I have used very various objectives with the blue

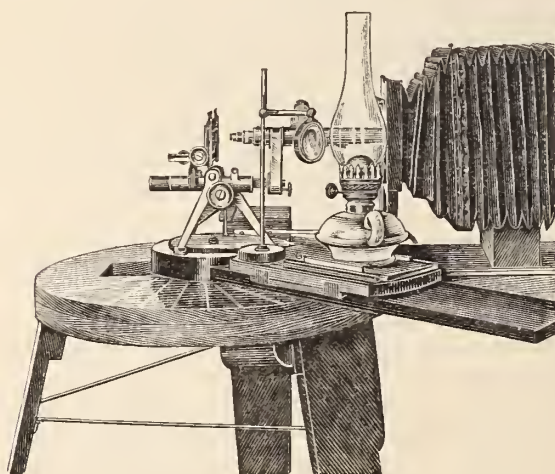
* This Journal, 1879, p. 664.

† Op. cit., 1885, p. 713.

cell and have not once noticed a want of coincidence of visual and actinic foci. Further, I have focused with lamplight not passing through the blue cell, and then photographed with the blue cell in place with a result quite inferior to the next, the next being obtained under the same conditions excepting that the blue cell was in place when focusing. The use of the blue cell in focusing secures excellent results with the Wales photo-objectives, corrected for the violet ray. After passing through the blue cell the light is received by a substage condenser and focused on the object. My substage not only carries ordinary Powell and Lealand achromatic condensers for high power work, but by means of adapters also carries, instead, an eye-piece or a suitable objective as a condenser for low-power work.

The round table-top expansion (figs. 35-37) is divided by degree markings, enabling me to turn the board supporting the lighting

FIG. 37.



apparatus to any required angle for oblique illumination of transparent objects, or so far around as to cause the light to fall at suitable angles on opaque objects. That end of the revolving board which is under the Microscope is circular. The upper surface of the circular portion presents two levels, a central circular higher level surrounded by a peripheral lower level. On the latter rest the three feet of the Microscope tripod, in such fashion that when the two feet away from the camera, or under the substage, are snugly against the edge of the central raised level, the object on the stage is in the vertical axis about which the board revolves. Therefore, after the board has been turned out of line for oblique illumination, the Microscope can be placed in new correct position immediately, by bringing the two feet mentioned against the edge of the higher level, and the eye end of the

axial tube to the centre of the camera front. In photomicrographing an opaque object, a diaphragm cap is slipped over the front of the objective. Thus a diaphragm comes to be supported about half-way between the object and the objective: it there cuts off all rays from the object or stage outside the area to be photographed, and is analogous to the hood of a portrait or landscape lens. When an objective has a short working distance, a piece of dead black card or paper with a central hole, instead of the cap, covers all the object except the area to be photographed. In photomicrography, as in all critical optical work, it is important here and everywhere to shut out or suppress, so far as possible, every non-effective or wandering ray of light. The wainscoting of my room is black; the woodwork of the apparatus is black; the walls and floor are non-actinic; by day I always photomicrograph with covered windows; and at night I have no light in the room but that on the revolving board.

In slide 52 (fig. 36) is also seen a small cubical box projecting from the front board of the camera. Within the box is a mirror which reflects the light from a white card, substituted for the ground-glass, through a single opera-glass fastened to the nearer side of the box. With this addition to the apparatus in place, I can sit at the side of the table, arrange the object and illumination with the eye at the side tube of the Microscope, withdraw the mirror from the axial tube and then, without getting up, look through the opera-glass and roughly focus an image on the white card. Focusing is then completed at the other end of the camera in the usual way by means of the fine-adjustment rod and pulley. At the left are seen two screw-clamps which are used in fixing the camera back at any required distance from the Microscope, the exact distance being shown by a scale cut on one side of the camera bed. The eye end of the tube is seen to be supported by an adjustable standard, a necessity in delicate work with high powers.

Slide 59 (fig. 38) shows an arrangement of apparatus for photomicrography with transmitted axial sunlight. To the left is an upright supporting a horizontal axial tube with a portion of its upper half cut away to allow an alum or water cell, an ammonio-sulphate of copper cell, a disc of ground glass, and diaphragms, one or more of these, to stand in the lower half. The Microscope is seen to the right. Between is an 8-in. portrait lens so supported by an upright that its distance from the Microscope can be varied at pleasure, by sliding the upright along the revolving board. The lens is attached to the upright by two sliding boards, one sliding vertically and one horizontally, for the purpose of centering. The portrait lens was originally intended to eliminate diffraction phenomena in accordance with the Woodward method;* but the lens is also occasionally used instead of a substage condenser. Outside a south window, slide 57 (fig. 39), is a Stratton

* Monthly Microscopical Journal, vi. (1871) p. 170.

FIG. 38.

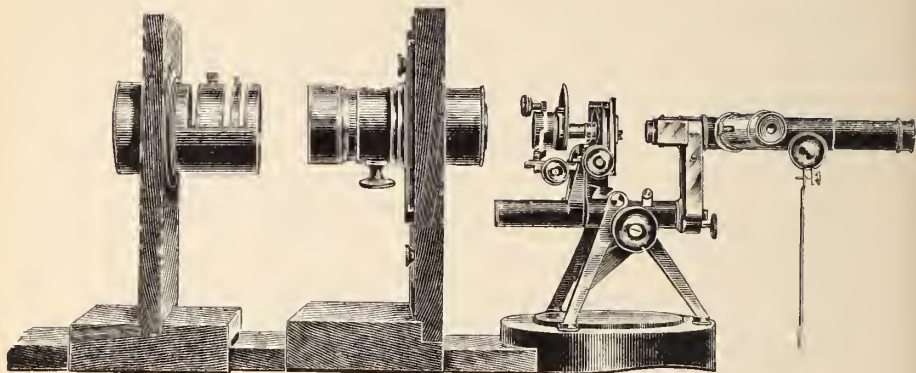
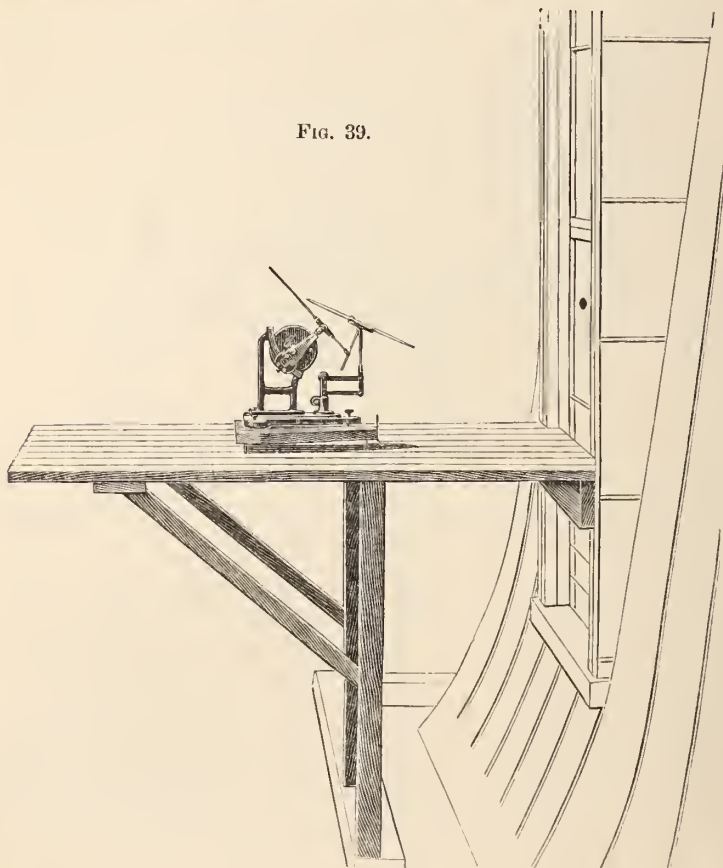


FIG. 39.



and Burrill heliostat* on a shelf-table. The window-sash is glazed with plate glass through which the light from the mirror passes without that deterioration which occurs when light passes through the wavy surfaces of an ordinary pane. The place for the heliostat is so marked that it can be within a minute accurately set and levelled over a meridian line cut in the surface of the shelf-table. I have neglected to say previously that the whole apparatus in the room is also accurately placed and levelled over an extension of the same meridian line cut in the floor. By referring to figs. 35 and 36 it will be seen that the table-top expansion is not directly supported by the three legs. The three legs support a ring into the lumen of which fits nicely but freely a circular plate of hard wood fastened centrally to and below the table-top expansion. This construction permits the camera and Microscope to be turned out of meridian while the revolving board remains in meridian for oblique illumination with sunlight. On returning the camera support to the meridian, cleats on the floor stop the instrument in correct position. In photomicrographing opaque objects by sunlight the heliostat is shifted to a meridian one foot to the east, as are also the alum and ammonio-sulphate of copper cells. The sunlight from the heliostat, after passing through the cells, is received by a long-focus concave mirror and reflected on the opaque object.

Slide 55 (fig. 40) is a photograph of a Powell and Lealand No. 3 stand with a side tube added for photomicrography and a lever attachment to the pinion of the draw-tube. The mirror, now in the side tube, can be moved into and out of the axial tube by means of the milled-headed screw seen under the side tube. It is obvious, too, that the use of the tubes can be reversed: the Microscope can be used in the vertical position, the object and illumination arranged in the ordinary way, then the mirror pushed into the axial tube to reflect the image-forming rays into a camera attached to the side tube. To the right is seen the adjustable standard for supporting the eye-end of the axial tube when horizontal. It is adjustable in height by means of the milled-head screw arrangement seen about one-fourth down the standard.

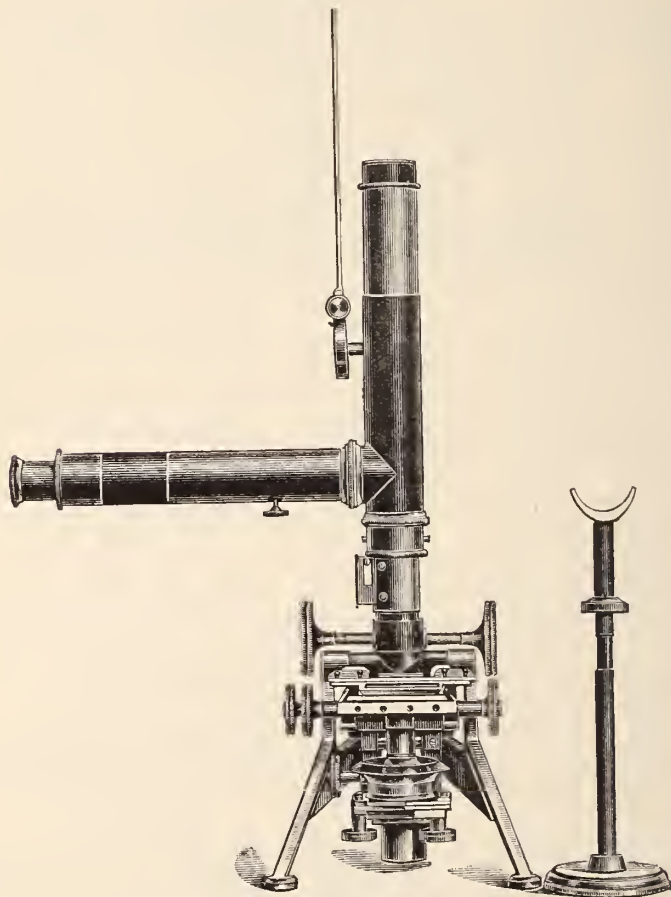
A convenience peculiar to the Powell and Lealand, or Ross, model of stand is shown in slides 61 and 62 (not figured). The axial tube is removed and its supporting arm turned to one side. By means of stage forceps various large objects are supported, or on a broad wood superstage a bit of manuscript is flatly fastened, while a short-focus doublet landscape lens on the camera front serves, instead of a Microscope objective, to cover a comparatively extensive area and give a perfectly flat field.

Exposures are made in a very simple way. While the sensitive plate is being placed, a black card stands close to the ammonio-

* Proc. Amer. Soc. Micr., 1885, p. 103.

sulphate of copper cell and intercepts the light. When the plate is in position and all the apparatus satisfactory, the light-intercepting card is removed for the required length of time and then replaced.

FIG. 40.



In bringing this paper to a close, I wish to acknowledge my indebtedness to Mr. Edward Bausch, of the house of Bausch and Lomb, for practically placing the resources of the firm's great factory at my disposal in the construction of the more special and fine brass-work so necessarily a part of the apparatus.

VII.—*The Foraminifera of the Gault of Folkestone.*—II.*

By FREDERICK CHAPMAN, F.R.M.S.

(Read 20th April, 1892.)

PLATES V. AND VI.

Family LITUOLIDÆ.

Sub-family LITUOLINÆ.

REOPHAX Montfort [1808].

Reophax lageniformis, plate V. figs. 1 *a* and *b*.

This form consists of a compressed flask-shaped chamber, the test of which is composed of fine sandy material of a brick-red or brown colour. The mouth is produced slightly beyond the circular contour of the shell, and is devoid of the colour present in the rest of it. Length $1/60$ in. This variety differs from *R. difflugiformis* in the compressed and non-elongate form of the shell, and from *R. ampullacea* in the latter characteristic, and also in the fine texture of the shell. A form somewhat resembling this is figured by M. Berthelin from the Gault of Montcley,† but the test is very coarsely arenaceous, whilst those of the Folkestone specimens are fine and smooth. It occurs in zone xi., at 35 ft. from the top, one specimen; and 6 ft., one specimen.

EXPLANATION OF PLATES.

PLATE V.

- Fig. 1*a*, *b*.—*Reophax lageniformis* sp. n. × 40.
 „ 2*a*, *b*. „ *ampullacea* Brady. × 40.
 „ 3. „ *fusiformis* Will. sp. × 40.
 „ 4. „ *scorpiurus* Montfort, small var. × 30.
 „ 5. „ „ „ coarse var. × 20.
 „ 6*a*. „ *Folkestoniensis* sp. n. × 30.
 „ 6*b*. „ „ Section showing the chambered interior. × 30.
 „ 7*a*. „ *cylindracea* sp. n. × 30.
 „ 7*b*. „ „ „ section. × 30.
 „ 8.—*Haplophragmium glomeratum* Brady. × 60.
 „ 9*a*, *b*. „ *nonioninoides* Reuss. × 30.
 „ 10. „ *elegans* sp. n. × 35.
 „ 11*a*, *b*. „ *acutidorsatum* Hantken. × 30.
 „ 11*c*. „ „ „ section. × 30.
 „ 12*a*, *b*. „ *latidorsatum* Bornemann sp. × 30.
 „ 13. „ „ var. *papillosa* n. × 35.
 „ 14. „ *agglutinans* d'Orb. sp. × 60.
 „ 15*a*, *b*, *c*. „ *nanum* Brady. × 30.
 „ 16. „ *globigeriniforme* P. and J. sp. × 60.

* For Part I. see this Journal, 1891, p. 565.

† *Haplophragmium scruposum* Berthelin, 1880, Mém. Soc. géol. France, sér. 3, vol. i. Mém. 5, p. 21, pl. i. fig. 1*a*, *b*.

Reophax ampullacea Brady, plate V. figs. 2 *a* and *b*.

Reophax ampullacea Brady, 1881, Quart. Journ. Micr. Sci., vol. xxi. N.S. p. 49. *R. ampullacea* Brady, 1884, Chall. Rep., vol. ix. p. 290, plate xxx. figs. 6 *a*, *b*.

The specimens from the Gault are precisely similar in appearance to the recent ones figured by Dr. Brady. It occurs with frequency in one stratum only, in zone xi., 12 ft. from the top.

Reophax fusiformis Williamson sp., plate V. fig. 3.

Proteonina fusiformis Williamson, 1858, Rec. For. Gt. Br., p. 1, plate i. fig. 1.

This form has hitherto been recorded only as a recent one. The fossil specimens, of which two have been found, exhibit the broad and narrow variation in the form of the shell; the former type is here figured. Zone x. one specimen (broad type); zone xi., 6 ft. from the top, one specimen (narrow type).

Reophax scorpiurus Montfort, plate V. figs. 4 and 5.

Reophax scorpiurus Montfort, 1808, Conchyl. Système, vol. i. p. 330, 83^e genre.

This is a recent form, but has also been recorded fossil by Messrs. Crosskey and Robertson from the Post-tertiary beds of Norway, and by Terquem from the Oolite of Fontoy, under the name of *Nodosaria agglutinans*. The specimens from the Gault consist of two varieties, a slender form (the initial portion of which has been broken off), and

PLATE VI.

- Fig. 1, 2.—*Haplophragmium æquale* Römer sp. × 60.
 " 3. " " " section. × 60.
 " 4.—*Placopsilina cenomana* d'Orb. × 45.
 " 5. " *vesicularis* Brady. × 45.
 " 6, 7.—*Haplostiche Sherborniana* sp. n. × 35.
 " 8. " " " decalcified section. × 35.
 " 9.—*Thurammina albicans* Brady. × 30.
 " 10a, b.—*Hormosina globulifera* Brady. × 30.
 " 11.—*Anomodiscus incertus* d'Orb. sp. × 60.
 " 12. " *tenuis* Brady. × 60.
 " 13. " *gordialis* Jones and Parker sp. × 60.
 " 14a, b.—*Trochammina concava* sp. n. × 30.
 " 15.—*Textularia minuta* Berthelin. × 40.
 " 16. " *sagittula* DeFrance. × 35.
 " 17a, b. " *gramen* d'Orb. × 35.
 " 18. " *trochus* d'Orb. × 35.
 " 19. " *turris* d'Orb. × 35.
 " 20. " *conica* d'Orb. × 35.
 " 21. " *agglutinans* d'Orb. × 40.
 " 22. " *parallela* Reuss. × 40.
 " 23. " *prælonga* Reuss. × 45.
 " 24a, b.—*Verneuilina triquetra* Münster sp. × 40.
 " 25a, b. " *variabilis* Brady. × 40.

a coarser form as regards the material of which its shell is composed, and also very much larger in point of size; the slender form is $1/15$ in. in length, whilst the coarse variety is $1/6$ in. long. The tests of both are white in appearance and the latter type has included fragments of fish-scales and small Foraminifera (*Bulimina*). The two specimens found were from zone x.

Reophax Folkestoniensis, plate V. figs. 6 *a* and *b*.

Test free, consisting usually of four slightly inflated chambers disposed in a straight or slightly curved line; coarsely arenaceous, white, and having imbedded brown fish-scales, small specimens of *Haplophragmium*, *Bulimina*, and fragments of extraneous organisms. Length $1/10$ in. This Foraminifer bears a close external resemblance to *R. Helvetica* of Dr. Haecusler; but since, on examining a number of the Gault specimens sliced vertically there appears to be a slight tendency towards a spiral growth in the commencement of the shell, though retaining the form in the genus *Reophax*, it seems advisable to give it a distinct specific name, especially as it is an interesting link between the straight and spirally formed arenaceous types. It occurs in one horizon only, zone x., where it is very common.

Reophax cylindracea, plate V. figs. 7 *a* and *b*.

Test composed of numerous short discoidal chambers disposed in a straight line. The segments increase very slightly in diameter with the growth of the shell. Texture somewhat coarsely arenaceous. The specimens were always found in a fragmentary condition. Diameter $1/20$ in. Zone x., common.

HAPLOPHRAGMIUM Reuss [1860].

Haplophragmium glomeratum Brady, plate V. fig. 8.

Lituola glomerata Brady, 1878, Ann. and Mag. Nat. Hist., ser. 5, vol. i. p. 433, plate xx. figs. 1 *a*, *b*, *c*. *Haplophragmium glomeratum* Brady, 1881, Denkschr. d. k. Akad. Wiss. Wien, vol. xliii. p. 100, No. 21.

This form is here recorded as a fossil for the first time. In the recent deposits it is a comparatively shallow-water form from high latitudes, but has been found at depths varying from 2160 to 2740 fathoms in tropical and sub-tropical areas (Brady). In the Gault it occurs in zone ii., specimen *c*, common; zone iii., rare; zone ix., very rare; zone xi., 12 ft. from the top, frequent.

Haplophragmium nonioninoides Reuss, plate V. figs. 9 *a* and *b*.

Haplophragmium nonioninoides Reuss, 1862, Sitzungsber. k. Ak. Wiss. Wien, vol. xlv. p. 30, plate i. fig. 8.
1892.

A very distinct Gault form, consisting of 8-12 chambers. The shell is composed of sandy particles of a pale to a ruddy-brown colour and of medium texture. The arched slit-like aperture is very nearly central. In a few examples the last chamber is developed to twice the usual length, thus imparting a crosier-like aspect to the shell. This species is recorded by Dr. v. Reuss from the Flammenmergel and Minimusthon of North Germany, and also as occurring "seldom and generally small and imperfectly formed" from the Folkestone Gault. A form from the Neocomian (?) beds of the Richmond Well-boring is recorded by Prof. Rupert Jones under the name of *Haplophragmium depressum*, Quart. Journ. Geol. Soc., vol. xl. p. 765, plate xxxiv. fig. 1, which closely resembles the above form. Zone i., specimen *b*, common; zone ii., specimen *b*, common; zone ii., specimen *c*, very common; zone iii., rare; zone iv., very common; zone v., very common; zone vi., frequent; zone vii., very common; zone viii., common; zone ix., common; zone x., very common; zone xi., 55 ft. from the top, common; 50 ft., common; 45 ft., very common; 40 ft. common; 35 ft., common; 30 ft., very rare; 25 ft., common; 12 ft., common; 6 ft., common.

Haplophragmium elegans, plate V. fig. 10.

This variety, which appears to merit a distinctive name, though perhaps only as one of local value, has probably arisen from *H. nonioninoides* by the angulation of the middle dorsal portion of each segment, thus giving to the shell the scalloped contour. In the shape of the aperture and in the width of the shell the two forms are similar. There are six chambers showing in the specimen figured. Diameter $1/35$ in. It is found in zone ix., one specimen; zone xi., 55 ft. from the top, one specimen.

Haplophragmium acutidorsatum Hantken, plate V. figs. 11 *a*, *b*, *c*.

Haplophragmium acutidorsatum Hantken, 1868, Magyar. Földt. Társulat., vol. iv. p. 82, plate i. fig. 1.

This species resembles *H. emaciatum* Brady, but with the difference that in the latter form the whorls are evolute, whilst in *H. acutidorsatum* they are involute. The specimens from the Gault are almost white, and consist of about eight chambers. The central portion of the side of each chamber is slightly concave, instead of presenting a full even surface as in the specimens figured by von Hantken from the Hungarian Tertiaries; and the slit-like aperture is placed slightly to one side. Fig. 11 *c* shows the chambered structure of the shell and also the stolon passages between the last few chambers; this is an example from the Gault of Merstham. It is found in zone i., specimen *b*, very rare; zone ii., specimen *b*, frequent; zone ii., specimen *c*, common; zone iii., very common; zone iv., frequent; zone v., frequent; zone vi., very rare; zone vii., rare; zone viii., rare; zone ix., very rare;

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zone x., frequent; zone xi., 55 ft. from the top, frequent; 50 ft., frequent; 45 ft., rare; 40 ft., frequent; 35 ft., frequent; 30 ft., very rare; 25 ft. very rare.

Haplophragmium latidorsatum Bornemann sp., plate V. figs. 12
a and b.

Nonionina latidorsata Bornemann, 1855, Zeitschr. d. deutsch. geol. Gesell., vol. vii. p. 339, plate xvi. figs. 4 a and b.

This form is readily distinguished from *H. nonioninoides* by its greater breadth, and in its consisting of fewer chambers, which rarely number more than six; in this form also the wall of the test is comparatively thick. Its arenaceous test is usually of a brownish-white colour, in the specimens from the Gault. In recent soundings it occurs as a deep-water form; and has been recorded fossil from the Septaria-clay of Hermsdorf by Bornemann, from the Salt-clay of Wieliczka in Galicia by Reuss (*H. crassum*), and from the Clavulina-Szaboi beds of Hungary by Hantken. Zone i., specimen a, very rare; zone i., specimen b, very rare; zone ii., specimen a, common; zone ii., specimen b, frequent; zone ii., specimen c, frequent; zone iii., rare; zone v., frequent; zone viii., frequent; zone ix., very rare; zone x., very rare; zone xi., 55 ft. from the top, very rare; 45 ft., rare; 35 ft., very rare; 12 ft. very common; 6 ft., very common.

Haplophragmium latidorsatum var. *papillosa*, plate V. fig. 13.

This variety resembles the preceding form in all its general characters, but differs in the appearance of its arenaceous test which has distributed over the surface numerous rough papillæ which are composed of the same moderately fine sandy material as the rest of the shell. These tubercles are most numerous along the dorsal edge of the test. There are about six chambers in the specimens found. Diameter 1/40 in. Zone x., two specimens.

Haplophragmium æquale Römer sp., plate VI. figs. 1, 2, and 3.

Spirolina æqualis Römer, 1840-1841, die Verstein. d. nord-deutsch. Kreidegeb., p. 98, plate xv. fig. 27. *Haplophragmium æquale* Röm. sp., Reuss, 1860, Sitzungsber. k. Ak. Wiss. Wien, vol. xl. p. 218, plate xi. figs. 2 and 3. *H. æquale* Röm. sp., Reuss, 1862, Sitzungsber. k. Ak. Wiss. Wien, vol. xlv. p. 29, plate i. figs. 1-7.

This species differs from *H. agglutinans* d'Orb. by the absence of an umbilical depression in the initial spiral portion, and in the inflation instead of compression of the spiral. It is a very variable form in the Gault clays; the two varieties figured show its chief characters. A section of the shell, not quite median, shows the chambered structure, which is represented on plate VI. fig. 3. Recorded by

Römer from the Chalk of North Germany, and by Reuss from the Upper Chalk and Wealden beds of Westphalia, and also from the Hils-thon near Brunswick and Speeton-clay between Grönenplan and Escherhausen. It is found in the Gault in zone i., specimen *b*, very rare; zone ii., specimen *a*, frequent; zone ii., specimen *b*, frequent; zone ii., specimen *c*, rare; zone iii., very common; zone iv., very common; zone vi., very rare; zone vii., very rare; zone x., rare; zone xi., 6 ft. from the top, very rare.

Haplophragmium agglutinans d'Orbigny sp., plate V. fig. 14.

Spirolina agglutinans d'Orbigny, 1846, For. Foss. Vien., p. 137, plate vii. figs. 10–12.

The range of this species in time is very extensive, making its first appearance in the Lower Carboniferous rocks of Yorkshire, occurring again in the Lias, Gault, Lower Tertiaries, Miocene, and also in recent deposits. In the Gault it is found in zone ii., specimen *c*, very rare; zone iii., very rare; zone xi., 45 ft. from the top, very rare; 35 ft., very rare; 12 ft., very rare.

Haplophragmium nanum Brady, plate V. figs. 15 *a*, *b*, *c*.

Haplophragmium nanum Brady, 1881, Quart. Journ. Micr. Sci., vol. xxi. n.s., p. 50. *H. nanum* Brady, 1881, Denkschr. d. Ak. Wiss. Wien, vol. xliii. p. 99, plate ii. fig. 1 *a–c*.

An inequilateral form found in deep-sea deposits. The Gault specimens are almost identical with the figures of the recent ones. Zone i., specimen *b*, very rare; zone ii., specimen *c*, very rare; zone iii., rare; zone xi., 6 ft. from the top, very rare.

Haplophragmium globigeriniforme Parker and Jones sp., plate V. fig. 16.

Lituola nautiloidea var. *globigeriniformis* Parker and Jones, 1865, Phil. Trans., vol. clv. p. 407, plate xv. figs. 46, 47. *Haplophragmium globigeriniforme* Parker and Jones sp., Brady, 1884, Chall. Rep., vol. ix. p. 312, plate xxxv. figs. 10, 11.

This is recorded by Dr. Brady as an essentially deep-water form. The only record of its occurrence as fossil is by Terrigi from the Upper Pliocene Sands of Rome. It is found in the Gault in zone iii., rare; zone v., very rare; zone vii., very rare; zone ix., very rare; zone xi., 35 ft. from the top, very rare; 12 ft., very rare.

PLACOPSILINA d'Orbigny [1850].

Placopsilina Cenomana d'Orbigny, plate VI. fig. 4.

Placopsilina Cenomana d'Orbigny, 1850, Prodr. Paléont., vol. ii. p. 185, No. 758. *P. Cenomana* Reuss, 1854, Denkschr. d. k. Ak. Wiss. Wien, vol. vii. p. 71, plate xxviii. figs. 4, 5.

The specimens from the Gault placed under this name are not so distinct in habit of growth as those from other formations; but after some deliberate study of their structure it seems that they must find a place here, as they possess a chambered structure, are roughly spiral, and have a coarsely arenaceous test. The specimen figured has included in its shell-wall a Rotaline Foraminifer. This species has been recorded fossil from beds of Jurassic and Cretaceous age, and it also occurs in recent deposits generally as a shallow water form. In the Gault it occurs in zone x., rare; zone xi., 20 ft. from the top, frequent.

Placopsilina vesicularis Brady, plate VI. fig. 5.

Placopsilina vesicularis Brady, 1879, Quart. Journ. Micr. Sci., vol. xix. n.s. p. 51, plate v. fig. 2.

Hitherto recorded only as a recent form. The Gault specimens occur in zone vii., rare.

HAPLOSTICHE Reuss [1861].

Haplostiche Sherborniana, plate VI. figs. 6, 7, 8.

Test nearly cylindrical or more rarely flask-shaped and unsegmented. The exterior thickly studded with glauconite grains, and the material forming the test cemented by a fine white arenaceous substance. In section the glauconite grains are seen to be disposed throughout the cementing substance; the sarcoid spaces irregular or feebly labyrinthic. This latter structure can only be made out by decalcifying a thin section, as the shells have been entirely filled with carbonate of lime during fossilization; the labyrinthic structure is represented in the section (plate VI. fig. 8) by the clear spaces.

The test terminates in a tubular neck of fine white arenaceous material. In some examples the test commences with a tolerably large fragment of extraneous material, thus giving it the appearance of an adherent form, as in fig. 7. The length varies from $1/24$ to $1/12$ in. I have much pleasure in naming this species after my friend Mr. C. D. Sherborn. This interesting Foraminifer is found in one horizon only, the "greensand seam" of zone xi., 20 ft. from the top, where it is very common.

Sub-family TROCHAMMININÆ.

THURAMMINA Brady [1879].

Thurammina albicans Brady, plate VI. fig. 9.

Thurammina albicans, Brady, 1879, Quart. Journ. Micr. Sci., vol. ix. n.s. p. 46. *T. albicans* Brady, 1884, Chall. Rep., vol. ix. p. 323, plate xxxvii. figs. 2-7.

The Gault specimens belong to the above species rather than to *T. papillata*, since they are of small size and have very few papillæ. Zone x., very rare; zone xi., 35 ft. from the top, very rare.

HORMOSINA Brady, 1879.

Hormosina globulifera Brady, plate VI. figs. 10 *a* and *b*.

Hormosina globulifera Brady, 1879, Quart. Journ. Micr. Sci., vol. xix. n.s. p. 60, plate iv. figs. 4, 5. *H. globulifera* Brady, 1884, Chall. Rep., vol. ix. p. 326, plate xxxix. figs. 1-6.

Dr. Brady records this as a recent deep-water form. One very perfect specimen from the Gault, zone i., specimen *a*.

AMMODISCUS Reuss, 1861.

Ammodiscus incertus d'Orbigny sp., plate VI. fig. 11.

Operculina incerta d'Orbigny, 1839, Foram. Cuba, p. 71, plate vi. figs. 16, 17. *Ammodiscus incertus* Brady, 1884, Chall. Rep., vol. ix. p. 330, plate xxxviii. figs. 1-3.

This form, which makes its first appearance in beds of Carboniferous age, has been recorded from the Red Chalk of Speeton, by Messrs. Burrows, Sherborn, and Bailey.*

In the Gault specimens the test is composed of very fine arenaceous material, and is usually of an orange-brown colour. A few specimens were found in which the shell is elliptical, thus closely resembling the specimen from the Red Chalk. Zone ii., specimen *c*, frequent; zone iv., rare; zone xi., 50 ft. from the top, very rare; 45 ft., very rare; 40 ft., common; 35 ft., rare; 30 ft., frequent; 25 ft., very rare.

Ammodiscus tenuis Brady, plate VI. fig. 12.

Ammodiscus tenuis Brady, 1881, Quart. Journ. Micr. Sci., vol. xxi. n.s. p. 51. *A. tenuis*, Brady, 1884, Chall. Rep., vol. ix. p. 332, plate xxxviii. figs. 4-6.

This form occurs in the Gault generally associated with *A. incertus*, and may be considered as a thin variety of that type. The figured specimen has the peripheral edge of the shell sharp, instead of rounded as in the recent forms figured by Brady; some of the Gault specimens, however, are in all respects similar. The specimen figured by Messrs. Burrows, Sherborn, and Bailey strikingly resembles the Gault forms. It occurs in zone iv., very rare; zone xi., 40 ft. from the top, rare; 35 ft., very rare; 30 ft., rare; 6 ft., very rare.

* This Journal, 1890, p. 552, plate VIII. fig. 8.

Ammodiscus gordialis Jones and Parker sp., plate VI. fig. 13.

Trochammina squamata-gordialis Jones and Parker, 1860, Quart. Journ. Geol. Soc., vol. xvi. p. 304. *T. gordialis* Carpenter, 1862, Introd. Foram., p. 141, plate xi. fig. 4. *Ammodiscus gaultinus* Berthelin, 1880, Mém. Soc. géol. France, sér. 3, vol. i. Mém. 5, p. 19, plate i. fig. 3, a, b. *A. gordialis* Brady, 1884, Chall. Rep., vol. ix. p. 333, plate xxxviii. figs. 7-9.

This form has also been found in the Red Chalk of Speeton, and the Gault of Montelely, Doubs (Berthelin); and also in several other formations of earlier and later ages. The specimens from the Folkestone Gault agree with the Speeton specimens in point of size, and there is also present in some examples a thickened centre, mentioned by Messrs. Burrows, Sherborn, and Bailey. It occurs in the Gault in zone ii., specimen c., very rare; zone xi., 55 ft. from the top, very rare; 50 ft., very rare; 40 ft., very rare; 25 ft. rare.

TROCHAMMINA Parker and Jones [1859].

Trochammina concava, plate VI. figs. 14 a and b.

Test, a nautiloid spiral; thin, and with a somewhat large umbilical excavation on each face. About five segments visible in the later portion of the shell, all of which are more or less concave; the sutures well marked. The shell is almost bilaterally symmetrical. Aperture a curved slit inclined to one side. Test, finely arenaceous, the surface somewhat smooth and of a grey colour. Diameter 1/30 in. Found in zone iii., rare; zone xi., 40 ft. from the top, very rare.

Family TEXTULARIIDÆ.

Sub-family TEXTULARIINÆ.

TEXTULARIA DeFrance [1824].

Textularia minuta Berthelin, plate VI. fig. 15.

Textularia pygmæa Reuss, 1862, Sitzungsber. k. Ak. Wiss. Wien, vol. xlv. p. 80, plate ix. fig. xi. *T. minuta* Berthelin, 1880, Mém. Soc. géol. France, ser. 3, vol. i. Mém. 5, p. 26.

This species was referred to as *T. pygmæa* by Dr. Reuss, but d'Orbigny having previously given this specific term to another, and distinct species, it has been renamed by M. Berthelin in the Memoir on the French Gault Foraminifera above quoted; it will therefore be necessary to deal with all references to *T. pygmæa* Reuss, in my first paper of this series, as *T. minuta* Berthelin. It is a very distinct form in the Gault washings, excepting in the uppermost portion of zone xi., where it tends to become larger and more attenuated. The specimen from which the figure was taken is from zone iv. Dr. Reuss obtained his specimens from the Minus-thon of North Germany; Messrs. Burrows, Sherborn, and Bailey obtained this species from the Red

Chalk of Hunstanton. It occurs in the Gault in zone iii., common; zone iv., frequent; zone v., frequent; zone ix., very rare; zone x., very rare; zone xi., 55 ft. from the top, frequent; 45 ft., common; 40 ft., very common; 35 ft., common; 30 ft., common; 25 ft., common; 20 ft., very common; 12 ft., common; 6 ft., frequent.

Textularia sagittula Defrance, plate VI. fig. 16.

Textularia sagittula Defrance, 1824, Dict. Sci. Nat., vol. xxxii. p. 177; vol. liii. p. 344;—Atlas, Conch., pl. xiii. fig. 5. *T. sagittula* J. Wright, Rep. and Proc. Belfast Nat. Field Club, 1873–74, App. p. 86.

This is a rare and widely scattered form in the Gault. Mr. Joseph Wright records this form as abundant in the Chalk of the North of Ireland. It has also been found fossil in the principal Tertiary beds. Zone iv., very rare; zone v., very rare; zone xi., 12 ft. from the top, very rare.

Textularia gramen d'Orbigny, plate VI. figs. 17 *a* and *b*.

Textularia gramen d'Orbigny, 1846, For. Foss. Vien., p. 248, pl. xv. figs. 4, 6.

In the Gault this form occurs very sparingly; it is separated from *T. agglutinans* on account of its broad and compressed form, and from the other *Textulariæ* for the coarseness of its test. It has been recorded from the Red Chalk of Speeton (Burrows, Sherborn, and Bailey). Zone xi., 45 ft. from the top, very rare; 12 ft., rare.

Textularia trochus d'Orbigny, plate VI. fig. 18.

Textularia trochus d'Orbigny, 1840, Mém. Soc. géol. France, vol. iv. p. 45, pl. iv. figs. 25, 26. *T. trochus* Brady, 1884, Chall. Rep., vol. ix. p. 366, pl. xliii. figs. 15–19, and pl. xlv. figs. 1–3.

This form is scarce in the Gault and must not be confused with *Valvulina conica* P. and J., which it very much resembles on first acquaintance. It has been previously recorded as a Cretaceous species, and also from the Red Chalk of Speeton (Burrows, Sherborn, and Bailey). Zone ii., specimen *a*, rare; zone xi., 20 ft. from the top, very rare.

Textularia turris d'Orbigny, plate VI. fig. 19.

Textularia turris d'Orbigny, 1840, Mém. Soc. géol. France, vol. iv. p. 46, pl. iv. figs. 27, 28. *T. turris* Brady, 1884, Chall. Rep., vol. ix. p. 366, pl. xlv. figs. 4, 5.

This is also a characteristic Cretaceous Foraminifer; Reuss records it from the Middle Hills formation of Northern Germany; and Messrs. Burrows, Sherborn, and Bailey note it from the Red Chalk

of Hunstanton and Speeton. One very fine specimen only, from the Gault, in zone i., specimen b.

Textularia conica d'Orbigny, plate VI. fig. 20.

Textularia conica d'Orbigny, 1839, Foram. Cuba, p. 135, pl. i. figs. 19, 20. *T. conica* Brady, 1884, Chall. Rep., vol. ix. p. 365, pl. xliii. figs. 13, 14; pl. cxiii. fig. 1 a and b.

This species, which has hitherto been found only in recent deposits, is confined to the top of the Gault. Zone xi., 50 ft. from the top, common; 45 ft., common; 40 ft., frequent; 35 ft., very common; 30 ft., rare; 25 ft., frequent; 20 ft., frequent; 12 ft., common; 6 ft., very rare.

Textularia agglutinans d'Orbigny, plate VI. fig. 21.

Textularia agglutinans d'Orbigny, 1839, Foram. Cuba, p. 136, pl. i. figs. 17, 18, 32-34.

This is a comparatively rare form in the Gault, many specimens apparently of this species on careful examination being referable to the genus *Gaudryina*. It is recorded from the Red Chalk of Speeton. Zone xi., 45 ft. from the top, common; 30 ft., very rare; 20 ft., very rare.

Textularia parallela Reuss, plate VI. fig. 22.

Textularia parallela Reuss, 1860, Sitzungsber. k. Ak. Wiss. Wien, vol. xl. p. 233, pl. xii. fig. 7.

This is a form easily distinguished from *T. agglutinans* by the approximate parallelism of its sides, although it is evidently related to the *T. agglutinans* type. Reuss records it from the Gault of the Rhine. It is found in zone xi., 50 ft. from the top, rare; 45 ft., common.

Textularia prælonga Reuss, plate VI. fig. 23.

Textularia prælonga Reuss, 1845, Verst. böhm. Kreid., i. p. 39, pl. xii. fig. 14.

This is a very variable form from the Gault; many specimens approach *T. anceps* Reuss, in being shorter and stouter than the type form. Zone xi., 50 ft. from the top, rare; 45 ft., frequent; 30 ft., rare; 25 ft., common.

VERNEUILINA d'Orbigny [1840].

Verneuilina triquetra Münster sp., pl. VI. figs. 24 a and b.

Textularia triquetra Münster, 1838, N. Jahrb., p. 384, pl. iii. fig. 19. *Verneuilina triquetra* Brady, 1884, Chall. Rep., vol. ix. p. 383, pl. xlvii. figs. 18-20.

This is well known from the Chalk, also recorded from the Red Chalk of Speeton (Burrows, Sherborn, and Bailey), and from the Plänermergel of Luschitz, Bohemia (Reuss). Zone i., specimen *a*, very rare; zone v., common; zone viii., rare; zone x., very rare; zone xi., 55 ft. from the top, rare; 50 ft., frequent; 45 ft., common; 40 ft., frequent; 35 ft., frequent; 30 ft., frequent.

Verneuilina variabilis Brady, plate VI. figs. 25 *a* and *b*.

Verneuilina variabilis Brady, 1884, Chall. Rep., vol. ix. p. 385, pl. xlvii. figs. 21-24.

In the Gault series of Foraminifera there are many specimens which agree almost minutely with Dr. Brady's species, and which appear to be depauperated and coarsely constructed (as regards the test) varieties of the typical *V. triquetra*. Hitherto this form has not been found as a fossil. Zone x., very rare; zone xi., 50 ft. from the top, very rare; 35 ft., frequent; 30 ft., very rare.

VIII.—*The Penetrating Power of the Microscope.*

By EDWARD M. NELSON.

(Read 18th May, 1892.)

It has long been recognized that the penetrating power of the Microscope, or what, in other words, is the capability of seeing two different planes at the same time, diminishes as the magnifying power is increased, as the aperture is increased, and as the refractive index of the mounting medium is lowered.

The late Dr. Carpenter placed an undue amount of importance on the penetrating quality of the Microscope, and by his erroneous teaching on this subject undoubtedly retarded the advance of microscopy. His error was twofold :—

(1) Penetration is not an unmixed advantage in the interpretation of microscopical images ; it is more often a positive disadvantage. In objects, the nature of which cannot be perceived by the naked eye, it is better to trust to focal adjustment than to the best visual appearance of depth, however obtained.

(2) A "low-angled glass for penetration" is not the best way of obtaining the desired end.

It should be particularly noted that the difference in penetration between a $1/4$ of 60° ($\cdot 5$ N.A.), and a $1/4$ of 140° ($\cdot 95$ N.A.) both with an amplification of 300 diams. (B eye-piece) is less than $1/20,000$ in.—an almost inappreciable quantity with those lenses.

In cases where I would use a $1/2$ -in. of $\cdot 5$ N.A., and an amplification of 150 diams. (B eye-piece), giving a penetration of $1/2500$ in., a biologist or histologist would use a $1/6$ of $\cdot 6$ N.A. (Zeiss D) with an amplification of 450 diams. (B eye-piece) and a penetration of about $1/20,000$ in.

For many years the world of microscopy heard a great deal of Carpenter's dictum, "low-angled glass for penetration"; a little time therefore spent on the examination of Dr. Carpenter's tables of powers and apertures in the ninth edition of the 'Encyclopædia Britannica' * will not be amiss.

We find here a $1\frac{1}{2}$ -in. of 20° and a 1-in. of 30° , powers 54 and 75 respectively ; these are full apertures required by the most critical workers for those amplifications.† No one could tell the difference in an image amplified 75 diams., with an apochromatic inch of $\cdot 3$ N.A. stopped down to $\cdot 26$ N.A., or $1/2$ -in. of $\cdot 65$ N.A., which fact demonstrates that there would be no gain in increasing the aperture of the inch beyond $\cdot 26$ N.A. with that amplification. As I stated in the 'English Mechanic' (1883), before the introduction of apo-

* Vol. xvi. p. 270.

† An apochromatic $1\frac{1}{2}$ of $\cdot 18$ or $\cdot 2$ N.A. is a want much felt.

chromatics, the goal to aim at is $\cdot 26$ N.A. for every 100 diameters of amplification.

We see, therefore, that Carpenter has in this table hit upon the ideal for the most critical work with *low powers*. It is easy to see how he arrived at it. These are the lenses he worked with, the plane mirror and daylight would yield a $3/4$ cone, and the cone would be focused on the object. He therefore unconsciously attained a critical image, and working largely with these lenses, he came to the only conclusion he could with justice arrive at, viz. that a large aperture gave the best results.

As his powers advance his images become more and more uncritical, and consequently we see the ratios of aperture to power becoming more and more fantastic. Taking the $1/4$ for instance, 50° to 80° , or $\cdot 42$ N.A. to $\cdot 64$ N.A., with powers of 200 to 300, if he had been a consistent reasoner, his 1-in. objective ought to have had 15° of aperture, or a trifle less than that possessed by the earliest achromatic inches made in this country.

In my own mind there is not the slightest doubt but that a $1/4$ should be capable of bearing a power of 400 diams.; therefore, in accordance with the ideal stated above, viz. $\cdot 26$ N.A. per 100 diams., its aperture ought to be $1\cdot 04$ N.A. It is nevertheless highly impolitic to make the $1/4$ an immersion, therefore $\cdot 95$ N.A. is the aperture it ought to have, because that is the highest aperture that can be advantageously put into a dry lens.

With regard to this table of apertures, Dr. Carpenter says, "He has the satisfaction of finding that his opinions on this point, which are based on long experience in the microscopic study of a wider range of animal and vegetable objects than has fallen within the purview of most of his contemporaries, are in accordance with the conclusions drawn by Professor Abbe from his profound investigations into the theory of microscopic vision." It will be as well to turn to the reference given (this Journal, 1882, pp. 300, 460), and see what are the ratios of aperture to power that Abbe gives:—1-in., power 40–80, aperture 18° ; $1/2$ -in., power 80–160, aperture 35° ; $1/4$ -in., aperture 60° : we see therefore that it is only in the $1/4$ -in. that they agree; in respect of Carpenter's favourite objective, the inch, they disagree very materially.

Abbe, although his conclusions are fallacious, is at least consistent with regard to the apertures of his 1-in. and $1/4$ -in., which Carpenter is not: this entirely cuts away the ground for Dr. Carpenter's satisfaction.

The views on penetrating powers which find acceptance among microscopists at the present time are those laid down by Prof. Abbe in this Journal.

He divides the penetrating power into two parts, one he calls "the accommodation depth," the other "the focal depth," and he states that "the visual depth" is the sum of these two quantities.

The method of obtaining these quantities is shown, and a table of the penetration of an objective of $\cdot 5$ N.A. for objects in air under various amplifications and with a myopic accommodation is given. It will be noticed that with low powers the accommodation depth accounts for the greater part of the depth of vision, but as the powers become higher, its effect rapidly diminishes.

We have here the means of applying a crucial test. If we take the lowest power in Abbe's table we find that the depth of vision is twenty-nine times as great as the focal depth. If, however, Abbe's table had been calculated for normal accommodation, the depth of vision would be thirty-five times greater than the focal depth. Now, as a photographic plate can have no accommodation, a photograph taken under similar circumstances ought to exhibit $1/28$ or $1/35$ of the penetration of the visual image, according as the eye is myopic or normal. I have performed these experiments and have failed to find any marked difference between the photographic and visual appearances of the image with normal vision, the same aperture, the same cone of illumination, the same amplification, and the same object being employed in both cases.

Prof. Abbe's table would, however, lead one to expect a great difference between the visual image and the photograph in the case of low powers.

With a 4-in. objective of $\cdot 08$ N.A. eye-pieced to give ten diameters, and with two objects in balsam having a difference of level amounting to $\cdot 5$ mm., if the upper object is perfectly focused the lower will be out of focus.

With a 2-in. objective of $\cdot 13$ N.A. eye-pieced to give an amplification of 20 diams., a difference of level of $\cdot 2$ mm. is sufficient to throw the lower object quite out of focus. These observations were moreover confirmed by one wholly unaccustomed to use either the Microscope or any optical instrument; this is worthy of note, because the appreciation of minute differences of focus and sharpness of images is, to a large extent, a matter of practice. I therefore conclude that the depth of vision with normal sight, and an aperture of $\cdot 08$ N.A. and a power of 10 diameters, is $\cdot 02$ in. in a medium of $1\cdot 5$ refractive index. This is nearly $1/7$ of the result obtained according to Abbe's formula, when his accommodation distance and circle of confusion are used, and nearly $1/9$, when calculated with my accommodation distance and circle of confusion.

We will now pass on to the photographic tests with low powers.

I photographed with a 3-in. objective of $\cdot 08$ N.A., and with a power of 10 diams., two foraminifera mounted in balsam, which were separated by $\cdot 008$ in. I also photographed the same object with an apochromatic 1 in. of $\cdot 3$ N.A. and a power of 20 diams. The results in both cases were practically identical with those obtained visually. For the higher powers an object peculiarly sensitive to focal adjustment was selected, and at the same time one not requiring

a wide angle to resolve it, viz. the intercostal spicules on *Triceratium favus* in the well-known preparation "Mud Cuxhaven" of Möller.

These spicules being at the angles of the large hexagonal structure are comparatively distant from each other, and therefore do not need great resolving power; but by choosing a part where they were on the curve of the valve, minute differences in focal depth could be instantly detected. There was a certain spicule, which, when viewed with a power of 2000 diams. and an aperture of 1.4 N.A., appeared dim, while the next one to it was sharp; this appearance was maintained both visually and photographically with various powers and apertures down to 250 diams., with an aperture of .65 N.A. With this last power the penetration with an object in balsam is nearly equal to 1/10 of one division of Powell and Lealand's fine-adjustment (say .00004 in.), a quantity almost imperceptible. We may say, therefore, that with powers ranging from 250 diams. obtained with a 1/4-in. objective of .95 N.A. and upwards, there is no penetration for normal sight.

With regard to accommodation depth, it should be especially borne in mind that as the accommodation distance lengthens, so also does the focus of the lens; in other words as p' increases, p also increases, because we are dealing with virtual and not screen images. A microscopist, when focusing, is said to accommodate at his nearest distance: if that is the case, any alteration in focal depth or penetration would be in a downward direction, as it is obviously impossible for him to accommodate up nearer than his nearest distance of vision.

So far we have been dealing with the examination of two objects at different levels, but when a plane object such as a balsam-mounted microphotograph is examined under a low power, the result is somewhat different. We shall find at first a sharp definite focus confined within very narrow limits. Let this image be placed a little out of focus, then by looking steadily at it and by straining the eye, it can be seen in what might appropriately be termed an uncomfortable focus. Let this process be repeated several times until, little by little, we reach a point from which, by no amount of straining can we recover the focus.

The difference between the upper and lower foci obtained in the above manner, with a 4-in. objective of .08 N.A. eye-pieced to give 10 diams., is 3 mm., and with a 2-in. of .13 N.A. eye-pieced to give 20 diams., it falls to 1.16 mm. We may say, therefore, that the penetration with a strained accommodation is about six times as great as ordinary accommodation.

Now, I conclude that no one with a focusing adjustment at hand would for a single moment think of straining his accommodating powers, for if an object at a different level from another object that was in the precise focus of the instrument did not come into focus perfectly naturally, the observer would instantly have recourse to the focusing adjustment, and by that means obtain a proper view of

the object. It would be therefore absurd in the extreme to call this penetration with strained accommodation the penetrating power of the Microscope.

Let us now see how the penetration with the strained accommodation of normal sight compares with that laid down by Prof. Abbe. Abbe's myopic accommodation (150 mm. to 300 mm.), power 10, N.A. $\cdot 08$ and a balsam mount, would give $3\cdot 125$ mm. for accommodation depth, and $\cdot 682$ for focal depth, or a total of $3\cdot 807$ mm., which is $\cdot 807$ mm. more than that of strained normal accommodation; but as the unstrained accommodating distance for normal sight, viz. 8 in. to ∞ , is greater than that of Abbe's myopic accommodation of 150 mm. to 300 mm., the penetration should also be greater, but this experiment shows that it is less.

So far we have been experimenting with normal sight only. If we try myopic sight we shall find that penetration will be greater than that for normal, instead of less, as Abbe's theory requires. It is very instructive to notice the treatment of the microphotograph under a low power by myopic sight. A myopic eye is unable to mention any definite focus. Myopic microscopists are always playing on their accommodating powers, and consequently are unable to find a precise focus with a low power. For this reason they are able to penetrate without straining their accommodation to a greater depth than persons with normal sight.

My theory of microscopic penetration due to accommodation is, that with normal vision the eye does not accommodate at its nearest but at its easiest distance of vision, and that in some unexplained way the accommodating power of the normal eye is to a certain extent paralysed when using a Microscope. Hence, there is only a very limited amount of penetration without strain on either side of the easiest accommodating distance. Moreover, a normal eye when using a Microscope and straining its accommodation to the utmost, is not able to compass so large a range of accommodation as it ordinarily does without any strain when not using a Microscope. A myopic eye, on the other hand, is continually straining its accommodation, and it is on this account that the paralysing effect of the Microscope is not so much felt.

But from experiments made with myopic persons, I should be inclined to think that all the paralysing effect is not removed, and consequently the penetration is not so great as Abbe's table would lead one to imagine.

It is interesting to note in passing, that the alteration in the magnifying power can be distinctly seen when performing the straining experiments with the microphotograph.

We will now pass on to the investigation of Prof. Abbe's tables, which are very simple, and are based on elementary principles, with which every microscopist is acquainted.

The difficulty about the whole matter, and for which I can find no

theoretical explanation, is why the penetration as determined practically does not agree with the results obtained theoretically by Abbe's method. For instance, we ought theoretically to get 5 mm. of penetration, but practically we only get 1/2 mm. Again, a myopic person, who theoretically should have less penetrating power than an emmetropic person, practically has more. To meet this the paralysis theory is suggested, but why there should be this paralysis, if it exists, I am unable to say.

Taking accommodation depth first, all microscopists know that for every different screen distance, there is a different focus for the lens. Similarly for every different distance of virtual image there is a different focus for the lens. Accommodation depth is merely the difference in lens focus for different virtual image distances. The calculation of these different foci is very simple.

Let us, in order to make it perfectly clear, take a real or screen image with a single biconvex lens first (fig. 41). It is well known that on either side of a lens there is a principal focal point. Now if we call the distance between the image on the screen and the principal focal point on that side of the lens w , and the distance between the object and the principal focal point on the other side of the lens v , and the focus of the lens f (see figs. 41 and 42), then

$$v = \frac{f^2}{w}. \quad (\text{For proof see } \textit{infra}.)$$

If we have another screen distance which we will call w' , we shall have another focus v' , and $v' = \frac{f^2}{w'}$. The difference of focus is therefore $v - v'$, which is equal to $\frac{f^2}{w} - \frac{f^2}{w'}$, and which may be more conveniently written $\left(\frac{1}{w} - \frac{1}{w'}\right) f^2$. If therefore, we put in for w the distance of least accommodation, and for w' that of greatest accommodation, the difference between these fractions will be the accommodation depth we require. In the case of a simple lens f is the focus of the lens, but in a compound Microscope f is the focus of the entire Microscope. This may be very easily determined if M the magnifying power and D the distance of vision are known, because $f = \frac{D}{M}$.

(In the absence of all knowledge of the well-known formula, $f = \frac{D}{M}$ the proof is given *infra*.)

If, however, the object is in any other medium but air, μ the refractive index of that medium must be taken into account. The accommodation depth is therefore $\mu f^2 \left(\frac{1}{w} - \frac{1}{w'}\right)$. When the sight is

normal and the longer accommodation is infinite, then $\frac{1}{w}$ vanishes and the depth becomes $\frac{\mu f^2}{w}$ which may be written $\frac{\mu w}{M^2}$.

The focal depth is practically the latitude of focus which must be allowed for fluff. An object has really a precise and definite focus, but because the eye is unable to perceive very minute alterations in the image, that very precise and definite focus cannot be found, because the eye allows a slight range on either side of the true focus. This range is focal depth. Its amount can be easily determined. The first point to ascertain is the amount of fluff to be allowed, or in other words the diameter of the circle of confusion. I think it is better to take for this the least separable distance s , at the usual distance of accommodation or w . If we call this $1/200$ in. at 10 in. it will probably not be far from the average, although it is a larger amount than I allow for my own sight. The focal depth is then directly proportional to μ the refractive index of the medium the object is mounted in, and f the focal length of the lens or entire Microscope, and inversely proportional to the numerical aperture N.A.

The focal depth is therefore $\frac{\mu f s}{\text{N.A.} \cdot W}$ which may be written $\frac{\mu s}{M \cdot \text{N.A.}}$.

The values for s and w ought to be determined for each individual case; the following, will serve for general purposes:—Normal or emmetropic vision: $s = .005$ in. = .127 mm.; $w = 10$ in. = 250 mm. Myopic sight: $s = .0035$ in. = .09 mm.; $w' = 6$ in. = 150 mm.

The total visual penetration for emmetropic sight is therefore $\frac{\mu w}{M^2} + \frac{\mu s}{M \cdot \text{N.A.}}$ which may be written

$$\frac{\mu}{M} \left(\frac{w}{M} + \frac{s}{\text{N.A.}} \right). \quad (\text{i.})$$

For myopic sight the expression will be somewhat longer.

$$\frac{\mu}{M} \left\{ \frac{w}{M} \left(1 - \frac{w}{w'} \right) + \frac{s}{\text{N.A.}} \right\}. \quad (\text{ii.})$$

Thus far we have only been explaining and simplifying Abbe's formulæ, so if his values for the different terms are put in, results identical to his will be obtained.

Examples.—Emmetropic sight, $w = 250$ mm.; $D = 250$ mm.; magnifying power $M = 10$; $\text{N.A.} = .1$; $\mu = 1.5$; $\omega = .0005$; $s = .127$ mm.

Abbe's method :—

$$\begin{aligned} & \mu \left(\frac{D}{M} \right)^2 \cdot \frac{1}{w} + \mu \frac{D}{M} \cdot \frac{\omega}{N.A.} \\ &= 1.5 \left(\frac{250}{10} \right)^2 \cdot \frac{1}{250} + 1.5 \times \frac{250}{10} \times \frac{.0005}{.1} \\ &= \frac{1.5 \times 625}{250} + 1.5 \times 25 \times .005 \\ &= \frac{7.5}{2} + .187 = 3.94 \text{ mm.} \end{aligned}$$

By my simplified formula with the same data—

$$\begin{aligned} & \frac{\mu}{M} \left(\frac{w}{M} + \frac{s}{N.A.} \right) = \frac{1.5}{10} \left(\frac{250}{10} + \frac{.127}{.1} \right) \\ &= .15 \times 26.27 = 3.94 \text{ mm.} \end{aligned}$$

We have found, however, that owing to the paralysis of the accommodation, the penetrating power falls short of the above theoretical values. We must, therefore, construct a table that will be of practical use. To this end I propose to multiply the first fraction in the bracket by $\frac{M}{100}$ for all magnifications up to 50 diameters.

It must also be understood that the above formulæ are constructed on the understanding that the cone of illumination is equal to the full aperture of the objective.

Now we know that the highest illuminating cone for the most critical work we can use is a $3/4$ cone; this will slightly increase the penetration, and we should have therefore to multiply the second term in the bracket by $4/3$. As, however, a $1/2$ cone is more generally used than a $3/4$ cone, it will be better perhaps to make the formula suit general rather than critical use.

Putting in these two corrections and simplifying, we have for general work up to 50 diameters for emmetropic vision, the formula

$$\frac{\mu}{M} \left(\frac{w}{100} + \frac{2s}{N.A.} \right). \quad (\text{iii.})$$

For powers of 100 and 150 diameters, I propose to drop the accommodation depth and use only the second term multiplied by 2, thus,

$$\frac{4 \mu s}{M \cdot N.A.} \quad (\text{iv.})$$

For powers from 200 diameters and upwards I propose to use the second term only, viz.

$$\frac{2 \mu s}{M \cdot N.A.} \quad (v.)$$

After 300 diameters on a balsam mount, the penetration becomes less than 1/10 of one division on the head of Zeiss's fine-adjustment, a quantity which may be neglected.

With regard to myopic sight, unless a large number of measurements of the accommodating powers for different degrees of myopia with the respective penetrating powers were made, it would be quite impossible to state what corrections should be made, and whether various degrees of myopia required different corrections. The following formula may be used as a very rough approximation up to 50 diameters.

$$\frac{\mu}{M} \left\{ \frac{w}{50} \left(1 - \frac{w}{w'} \right) + \frac{2s}{N.A.} \right\} \quad (vi.)$$

With the data given in our example above, the corrected penetration for normal sight will be

$$\begin{aligned} & \frac{1.5}{10} \left(\frac{250}{100} + \frac{2 \times .127}{.1} \right) \\ &= .15 (2.5 + 2.54) = .756 \text{ mm.} \end{aligned}$$

This is 1/5 of the previous result; if, however, a full cone had been used in this instance as in the former, this result would have been 1/7. Another question arises, viz.: What is the photographic penetrating power?

If we assume that the permissible amount of fluff is double that of the visual image, it will be the same as that of formula (iv.).

It only remains now to construct a table of penetration which will yield values in agreement with practical results. The following table, although based on formulæ obtained theoretically, is really empirical, owing to the corrections that have been applied.

Being unable to find a reason for the paralysing effect, it is impossible to construct a formula on theoretical grounds that will meet the case.

With regard to optical formulæ which are frequently applied to the Microscope, it is, I think, a great pity that the proof is assumed. As the proof is not given in the text-books, that for the two formulæ used in this paper, and which, moreover, are always occurring in microscopical papers, is appended. I start from the

well-known fundamental optical formula $\frac{1}{p} + \frac{1}{p'} = \frac{1}{f}$, but would ask those who wish to take an intelligent interest in the theoretical

side of the Microscope, to study the chain of proof of this fundamental formula from "Snell's law of sines," "refraction through a prism," and "refraction through a thin lens," which are given in most text-books of physical science.

TABLE OF PENETRATION.

Data.—Vision emmetropic, $W = 250$ mm.; $S = .127$ mm'.

Balsam mounted objects, $\mu = 1.5$.			Penetration.	
Formulae.	Power.	Aperture.	Visual.	Photographic.
(visual)	10	.1	mm.	mm.
(iii.)	20	.2	.756	.76
	50	.3	.283	.19
	100	.3	.1	.051
(iv.)	150	.3	.025	.025
	200	.5	.01	.01
	250	.5	.0035	.007
(v.)	300	.5	.003	.006
	250	.95	.0016	.0032
	300	.95	.0013	.0026
	300+	—	now inappreciable.	—
(photographic) (iv.)	—	—	—	—

FIG. 41.

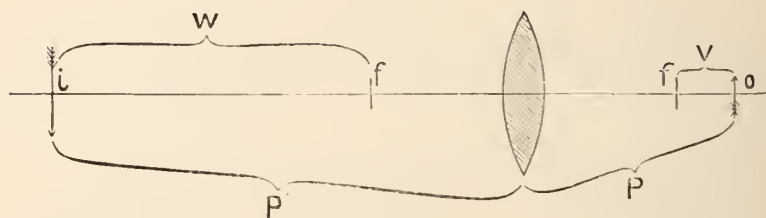
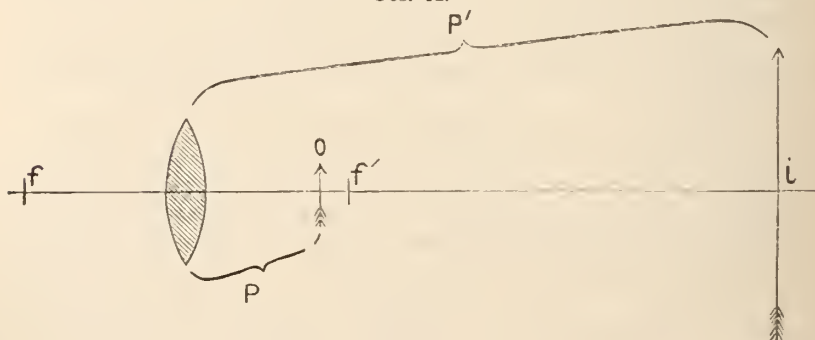


FIG. 42.



* Proof that $v = \frac{f^2}{w}$.

$$\frac{1}{p'} + \frac{1}{p} = \frac{1}{f}; \quad p' = w + f; \quad p = v + f;$$

$$\frac{1}{w+f} + \frac{1}{v+f} = \frac{1}{f}; \quad (w+f)(v+f) = (w+v+2f)f;$$

$$wv = f^2; \quad v = \frac{f^2}{w}.$$

Proof that $f = \frac{D}{M}$. i = image, o = object.

$$M = \frac{i}{o} = \frac{p'}{p}; \quad D = p' + f;$$

$$\frac{1}{f} = \frac{1}{p} - \frac{1}{p'}; \quad f = \frac{pp'}{p' - p}; \quad f(p' - p) = pp';$$

$$fp' = (p' + f)p; \quad f = \frac{p' + f}{\frac{p'}{p}} = \frac{D}{M}.$$

The above figures illustrate the formula on page 181 *ante*.

* First demonstrated by Sir Isaac Newton.

Erratum.—Page 336, line 5 from bottom, for “(In the absence of all knowledge of the well-known formula, $f = \frac{D}{M}$ the proof is given *infra*)” read “(In the absence of all knowledge of the well-known formula, $m = \frac{d}{f}$, see p. 182 (ii.), the proof is given *infra*.)”

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(*principally Invertebrata and Cryptogamia*),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

A. VERTEBRATA:—Embryology, Histology, and General.

a. Embryology.†

Transmission of Acquired Characters.‡—Prof. R. S. Bergh makes a vigorous attack on the doctrine of the non-inheritance of acquired characters. The weak point which he finds—one which others have previously noticed—is that there is insufficient evidence in support of the conclusion that the nucleus is the sole bearer of hereditary qualities. The cell-plasma, and especially the centrosomata, must be taken account of. This Prof. Bergh illustrates from several sets of facts.

Evolution of Man.§—Over the well-known initials “A. M. M.” there is a very interesting review of the fourth edition of Prof. E. Haeckel’s ‘Anthropogenie’; while the work is, from several points of view, recommended to the general reader, it is pointed out that the account of the development of the human embryo is very unsatisfactory and imperfect; in the last ten years our knowledge on this subject has increased so much that it is “from a stage corresponding to a chick-embryo at the commencement of the second day onwards as complete and as well illustrated as that of any other Mammal.” For this we are chiefly indebted to the splendid work of Prof. His.

The Human Ovum.||—Prof. M. Holl describes several ovarian ova. Each showed a tunica adventitia, which measured $4\ \mu$ in thickness on ova of 84–88 μ , and was concentrically marked, but without radial

* The Society are not intended to be denoted by the editorial “we,” and they do not hold themselves responsible for the views of the authors of the papers noted, nor for any claim to novelty or otherwise made by them. The object of this part of the Journal is to present a summary of the papers as *actually published*, and to describe and illustrate Instruments, Apparatus, &c., which are either new or have not been previously described in this country.

† This section includes not only papers relating to Embryology properly so called, but also those dealing with Evolution, Development, and Reproduction, and allied subjects.

‡ Zool. Anzeig., xv. (1892) pp. 43–52.

§ Natnre, xlv. (1892) pp. 482–3.

|| Anat. Anzeig., vi. (1891) pp. 548–56 (4 figs.).

striation or pores. On an ovum of $94\ \mu$ there was a distinct micropyle near the nucleus. There is no circumvitelline space. The cell consists at first of protoplasm alone, but afterwards of deutoplasm also. With growth the form changes from round to oval, and chromatin fragments pass from the nucleus into the cell-substance. The nucleus, at first round and central, becomes slightly oval and ex-centric; the part at which the nucleolus lies is always nearest the surface of the ovum. The nuclear membrane, at first slightly undulating, becomes quite smooth. With the passage of chromatin fragments from the nucleus to the cell-substance the nuclear framework gradually disappears, but the nucleolus—"the most essential part"—persists, though changed during maturation into a clump of chromatin spheres.

"Oolysis" in Seps.*—Dr. P. Mingazzini describes the complex destruction of ova—i. e. the "oolysis"—which occurs in the ovary of *Seps chalcides*. Only a small percentage of the large number of ova produced are utilized, and phenomena of degeneration occur comparable to those which Sanfelice has described in the testis. Apart from the ovarian degeneration, there is also a destruction of embryos at various grades of development; this does not seem to be injurious to adjacent ova, which undergo normal development.

Fertilization of Ovum of Slow-worm.†—Dr. A. Oppel has observed in the fertilized ova of *Anguis fragilis*, the formation of a male and a female pronucleus, and their gradual approach to one another. Besides the male pronucleus there were usually numerous accessory sperm-nuclei of unknown significance. The male pronucleus exhibits a protoplasmic field with radiations. The structure formed in conjugation exhibits a regular division-figure, whose axis is approximately parallel to the surface of the blastoderm. From this division arise the two first segmentation-nuclei. The accessory sperm-nuclei play no part in the conjugation of nuclei; they undergo several divisions and then abort. The protoplasmic field of the sperm-nucleus is formed under the influence of this element, and the radiations from it extend through the blastoderm to the surface.

Gelatinous Sheath round Frog Ova.‡—Dr. H. Bernard and Herr K. Bratuscheck have discovered a new utility in the spheres of frog spawn jelly. It has been pointed out by various naturalists that this sheath protects the ova from drought, pressure, birds (except ducks), fishes, water-snails, &c. The authors also show that *Gammarus pulex* seems to have a great repugnance to the slime, and also to the young tadpoles, perhaps on account of some bad taste. The spheres also preserve interspaces between the crowded eggs, and in these there are usually nests of green swarm-spores, which must likewise be advantageous. And is it not the case that the gelatinous envelope is of some moment in connection with the penetration of spermatozoa?

But what the authors have shown is this:—The envelope aids the pigment of the ova in utilizing the heat of the sun's rays, allowing these to pass through, but retaining those of longer wave-length, which radiate

* Atti R. Accad. Lincei, ser. v. i (1892) pp. 41-5.

† Arch. f. Mikr. Anat., xxxix. (1892) pp. 215-90 (4 pls.).

‡ Biol. Centralbl., xi. (1891) pp. 691-L.

out from the ova. In fact, each sphere of jelly is a little incubator. Figures relating to the physical demonstration of this are given. Among other interesting facts, it is noted that the spawn sinks in water in which there are no plants, but is in normal conditions buoyed up by the gas-bubbles liberated from water-plants.

Maturation and Fertilization of Trout Ova.*—Dr. H. Blanc finds that in the maturation of the ovum of the trout (*Trutta lacustris*) two polar bodies are extruded, and a "solar centre" accompanies the female pronucleus. The spermatozoon when transformed into a male pronucleus has also its solar centre. In fertilization, the two pronuclei fuse, and so do their solar centres.

Gonads of Amphioxus.†—Dr. Th. Boveri finds that the somites of *Amphioxus*, from 10–35 or 36, include not only a myotome and a sclerotome, but a third definite part—a "Gonotome." This may be defined as a definite ventral portion of a somite, bounded by anterior, posterior, medial, and lateral walls. The two last pass ventralwards into one another. Dorsally the gonotome is in open connection with the united sclero-myotome. The medial wall is continued into the skeletogenous layer of the sclerotome, the lateral into the cutis-layer of the myotome, while the anterior and posterior walls are continued into the muscle-septa. When somite and lateral plates are still one, the gonotome—as the most ventral part of the somite—must border directly on the lateral plates. But this definition holds good for the nephrotomes or gononephrotomes of Craniota, which in their ventral regions contain the primitive reproductive cells. The gonotome of *Amphioxus* is homologous with the gononephrotome of Craniota, and the archinephric canals of the latter correspond to the genital chambers of *Amphioxus*.

Nutritive Importance of Yolk-sac.‡—Dr. A. Robinson, who has made observations on the mouse and the rat, comes to the conclusion that in Rodents, as well as in Insectivora and Marsupials, the yolk-sac is an important nutritive organ. In the rat and mouse, indeed, the yolk-sac is the only foetal organ of nutrition during a certain period of development. The author thinks that the almost constant appearance of the hypoblast in the placental area, and the fact that it enters that area from different situations in different animals are indications of its functional importance during intra-uterine development: the hypoblast is not merely a framework which carries the splanchnic mesoblast on its expanding surface, and brings it into contact with the trophoblast, but it is an active agent of considerable importance during the later periods of development.

Formation of Peripheral Nervous System of Vertebrates.§—M. P. Mitrophanow, thinking that too much stress has been laid on the lessons learnt from the development of the Chick, has made his fundamental observations on Selachians. In them he finds that the edges of the medullary plate first come together in the region of the hind- and

* Bull. Soc. Vaud. Sci. Nat., xxvii. (1892) pp. 272–5.

† Anat. Anzeig., vii. (1892) pp. 170–81 (12 figs.).

‡ Journ. Anat. and Physiol., xxvi. (1892) pp. 208–23 (1 pl.).

§ Comptes Rendus, cxliii. (1891) pp. 659–62.

mid-brains, and it is in this region also that the nervous tube first becomes separated from the epidermis. The epidermis, when histologically differentiated, forms a kind of groove, the walls of which form an angle into the nerve-tube; the walls of this last gradually fuse towards the periphery, and little by little push out the epidermic groove. This accomplished, the nerve-tube becomes completely separated, and the groove is converted into a thickening; as there is here no separate morphological formation, there can be no question as to the formation of the foundation of the peripheral nervous system.

This latter system is differentiated thus; the foundation of it appears after the closing of the nerve-tube, and its separation from the ectoderm; it arises in the upper wall of the tube in consequence of the multiplication of the elements of the tube, which alter in position as they divide; the further growth of the system depends on the independent multiplication of its elements. It appears first in the region of the parietal inflexion, and extends forwards as far as the neuropore, and gradually becomes differentiated posteriorly. The part first to become separated is the nervous group in front of the trigeminal, and then follow others, so that five nerve-groups are for a long time in connection.

In the Sauropsida the differentiation of the foundations of the peripheral nervous system is accomplished before the nerve-tube closes and separates from the ectoderm; when the tube closes the foundations are found in the space between the tube and the ectoderm. Other differences from the Selachians, which may be taken as typical of the Ichthyopsida, are pointed out, and may be explained as due to the general differences in the development of these two great groups.

We may conclude that the peripheral nervous system is typically developed in direct dependence on the central system; the ectoderm itself takes no part in its formation; in the body the development of the spinal nerves exhibits primitive characters in all Mammals; there is, for the whole of the peripheral nervous system, a general germ which is gradually developed from before backwards, and is afterwards dislocated; this dislocation may be considerable in the anterior region before the germ has appeared further back; in this case the Selachians exhibit primitive characters.

Development of Segmentation-cavity, Archenteron, Germinal Layers and Amnion of Mammals.*—Dr. A. Robinson commences with a general description of the development of the ova of the rat and mouse up till the period of the completion of the blastodermic vesicle; he finds that there is a segmentation-cavity which is not the blastodermic; it disappears at the time when the archenteron, which is developed amidst the hypoblast, appears. The young ovum consists principally of hypoblast, which becomes vacuolated to form the cavity of the yolk-sac. The cavity of this sac is never bounded by epiblast alone; this layer extends over the outer surface of the hypoblast, but the latter is never entirely surrounded by epiblast.

The mesoblast is described as being formed partly from the peristomial cells in the region of the primitive streak, partly from the embryonic hypoblast, and partly from the extra-embryonic hypoblast.

* Quart. Journ. Mier. Sci., xxxiii. (1893) pp. 369-455 (5 pls.).

The formation of the mesoblast commences at the posterior end of the embryonic area, and not at the anterior, as in the hedgehog.

The notochord is formed entirely from the primitive hypoblast, to which it last remains adherent at the dorsal end of the bucco-pharyngeal membrane and the anterior end of the primitive streak; there is no cephalic process ("Kopffortsatz") of the primitive streak.

The author next compares the ova of the rat and mouse with those of other Mammals and those of lower Vertebrates. He finds that there is no essential difference between the ova of Mammals and those of other Vertebrates. They do not consist in the early stages of an epiblastic vesicle containing an inner mass of epiblast and hypoblast, but of a large hypoblastic mass which supports a small epiblastic disc. The ova of Mammals, in fact, present all the characteristic features of comparatively large-yolked ova.

With regard to the formation of the amnion and its relation to inversion, Dr. Robinson states that there is no pro-amnion in the rat or mouse. Pro-amnion formation and "inversion" are distinct processes, and "inversion" is not precocious pro-amnion formation. The whole of the amnion is formed from the tail-fold. The cœlom commences to be formed bilaterally and in the embryonic area; the pericardial cœlom is an extension of the embryonic cœlom from behind forwards, and it does not communicate with the anterior portion of the extra-embryonic cœlom.

Tail of Human Embryos.*—Dr. F. Keibel finds that the tail-like caudal process of young human embryos (between 4.2 and 11.5 mm.) is a true segmented tail. In the youngest stage observed three segments were seen, and, later on, six could be counted. The nervous system of this tail is much better developed in the embryo than in the adult. The medullary tube extends as far as the tip of the tail, where it fuses with the notochord, enteron, and mesoderm. Four spinal ganglia and two spinal nerves could be made out with certainty.

Embryology of Dentition of Marsupials.†—Prof. W. Kükenthal has made the important discovery of a milk-dentition in *Didelphys*; this appears to overthrow the generalization that only one tooth in Marsupials undergoes successional change, and indicates that the Mammalia were primitively diphyodont, and that the milk-dentition is not, as some have supposed, a secondary development.

Development of Apteryx.‡—In his memoir on the development of *Apteryx*, Prof. T. Jeffery Parker proposes the following new terms:—

Chondrite, an independent cartilaginous element or centre of chondrification.

Osteite, an independent element or centre of ossification.

Centrochondrite, cartilaginous, *Centrosteite*, bony, elements of a vertebral body.

Neurochondrite, cartilaginous, *Neurosteite*, bony, elements of a neural arch.

* Anat. Anzeig., vi. (1891) pp. 679-5 (2 figs.).

† Tom. cit., pp. 658-66; translated in Ann. and Mag. Nat. Hist., ix. (1892) pp. 285-94 (8 figs.).

‡ Philosoph. Trans., 182b (1892) pp. 25-134 (17 pls.).

Pleurochondrite, cartilaginous, *Pleurosteite*, bony, elements of a rib, or autogenous transverse process.

Prochordal plate, the middle trabecula of Rathke; a mass of blastema formed above the upturned anterior end of the notochord, and continuous behind with the parachordals.

Prochordal cartilage, a nodular chondrite which appears in the prochordal plate and gives rise to the mediodorsal portion of the dorsum sellæ.

On the whole, Prof. Parker inclines to the view that the Ratitæ are the descendants of birds which possessed the power of flight, and that they sprang from a "protocarnate" stock. On the hypothesis of its development from an ordinary reptilian fore-limb, the wing is one of the most striking examples of the uselessness of incipient structures.

Embryology of American Alligator.*—Mr. S. F. Clarke finds that the American Alligator deposits about thirty eggs in large nests close to a stream or pool. On each egg, soon after it is laid, there appears a transverse median zone which has a more chalk-white colour than the rest. This change is mainly due to a change in the shell-membrane. At first the embryo usually lies towards one pole of the egg, where it has the protection of the large mass of thick white; later on, when more perfect respiration is needed, it moves over to a lateral position.

The anterior or cephalic portion of the neural folds is formed by a median backward folding on the dorsal side of a thickened part of the head-fold; this median fold separates at its apex, and each arm unites with the medullary fold of its respective side. The intestine passes out of the body to become attached to the yolk-sac. The pharyngeal clefts are five, and the first three become open to the exterior. The anterior one appears first as an internal groove lined by thickened epithelium; this groove extends backwards and enlarges dorso-ventrally into the second cleft, and, in like manner, growing backwards, gives rise to the remaining three. All traces of the groove between the clefts soon disappear.

Life-history of Vermilion-spotted Newt.†—Prof. S. H. Gaze gives an account of the remarkable life-history of *Diemyctylus viridescens*. The ova are laid in water, and give rise to larvæ with well-developed gills; in the course of development these larvæ take on the general viridescent colour of the adult. The gills are absorbed, the coloration changes somewhat, the oral epithelium becomes ciliated, and the respiration and life become wholly terrestrial. In two or three years the newt loses its red colour and becomes again viridescent, returns to the water, loses its ciliated and reacquires a stratified non-ciliated oral epithelium, and during the remainder of its life is properly an aquatic form.

Tadpoles of European Batrachians.‡—Mr. G. A. Boulenger gives an interesting account of the tadpoles of European Batrachians, in which he gives a key by which the eight genera and nineteen species may be distinguished. The longest known European tadpole is that of *Pelobates fuscus*, which measures 175 mm., and the shortest that of *Bufo calamita*, which is only 30.

* Journ. of Morphology, v. (1891) pp. 181-214 (5 pls.).

† Amer. Nat., 1891, pp. 1084-1110 (1 pl.).

‡ Proc. Zool. Soc. London, 1891 (1892) pp. 593-627 (3 pls.).

Fertilization of Elasmobranchs.*—Herr J. Rückert has made some observations on the process of fertilization in *Pristiurus* and *Torpedo*. The merocytes or daughter-nuclei present in the young cleavage-stages of Selachians are not derived from the cleavage-nuclei, but are present before the copulation of the pronuclei. They are at that time exactly like the male pronucleus, and from what the author has been able to see in two cases he is led to believe that they have a similar origin to that body. If this be so, we may conclude that in Selachians there is a physiological polyspermy, and that a number of merocyte-nuclei are formed from the spermatozoic heads that make their way into the germinal discs as well as the male pronucleus.

B. Histology.

Cell-division.†—Prof. W. Flemming gave at the meeting of the German Anatomical Society an account of the most important advances in the cell-theory since 1887. Attention was particularly directed to the discovery by E. van Beneden of attraction spheres and central bodies. The essence of van Beneden's doctrine is that there is in the cell, in addition to the nucleus, a permanent organ of a special kind—the attraction sphere with the central body; this organ reproduces itself by division, if the cell does. The division of the central body precedes that of the cell. The rays of the sphere are contractile fibrils which attach themselves to the chromosomes, and draw their halves towards the poles. They thereby obtain a hold, for the polar bodies are connected, by the fibrils of the polar radiations, with the general contractile cell-structure. An important part, therefore, of the phenomena of mitosis has its cause not within but outside of the nucleus. Van Beneden supposed that the spheres and central bodies were quite generally distributed in all kinds of cells; not only have they been found when mitotic division has been going on, but Flemming has lately discovered them in resting cells. In this important address the relations of the central bodies to secondary and daughter nuclei are also considered, as are also the mechanics of mitotic and amitotic cell and nuclear division.

The Attractive Sphere.‡—Prof. E. van Beneden has a report on a memoir of Dr. O. Van der Stricht.§ He reminds the reader that, in 1887, he discovered in the fertilized ovum and the blastomeres of *Ascaris megalocephala*, a permanent cellular organ which lay beside the nucleus. The middle of this "attractive sphere" is occupied by a "cytcentre," around which a medullary and a cortical zone, concentric to the central corpuscle, may be distinguished. This sphere undergoes modifications like those seen in the cell in repose or during kinesis, but it never disappears; it divides before the nucleus, after the division of its cytcentre. An important part of the achromatic elements, of which the mitotic figures are composed, arise from the attractive spheres. The achromatic spindle was shown not to have a real existence, but that which does exist is a pair of fibrillar cones; the constituent fibres are clearly endowed with contractility, like muscular fibres, and the whole of the achromatic

* Verh. d. Anat. Ges. 5ten Versamml. (1891) pp. 253-4.

† Tom. cit., pp. 125-44.

‡ Bull. Acad. Roy. de Belgique, lxii. (1892) pp. 77-82.

§ Tom. cit., pp. 167-92 (1 pl.).

elements, derived partly from the attractive spheres, form a mechanism which determines the separation of the secondary chromosomes.

The study of these facts led to the generalization that in all animal and vegetable cells there is an attractive sphere; and the truth of this has been confirmed by the studies of many observers of animal and plant life. M. van der Stricht has studied the sphere in the blastomeres of *Triton* and in the cartilaginous cells of various Amphibia. He inclines to the view that the nuclear vesicles of the reconstituted nuclei are formed by the fusion of the ends of the chromatic loops, but he does not make the assertion definitely. In *Triton* he finds that the division of the attractive spheres of the egg is effected, as a rule, in the quiescent stage of the nucleus, rarely during the anaphasis of the mother nucleus, and exceptionally during its metaphasis. Dr. Van der Stricht is satisfied that he brings forward sufficient information to justify a belief in the existence of attractive spheres in cartilaginous cells.

γ. General.

Protective Resemblance in the Animal Kingdom.*—M. F. Plateau gives a general account of protective resemblance, and points out how general it is; there are scarcely any animal forms that do not, at some period of their existence, have recourse to imitation. In temperate Europe we may meet, at every step, with cases not inferior to any presented in the tropics. These phenomena are not, however, the results of ratiocination; it is in Man only that imitation with intent to deceive his neighbour is the result of the association of ideas.

Voyage of the 'Albatross.'†—Prof. A. Agassiz has published a general sketch of the expedition of the 'Albatross' from February to May 1891, on the western side of America and to the Galapagos. Some of the most striking passages are those in which the author deals very incisively with the claims of Prof. Haeckel to pose as an authority on pelagic work. The "zoological pope at Jena" is said to have had "no experience whatever at sea of the sort of pelagic work which he so complacently condemns *ex cathedra*. The observations on the pelagic fauna, on which Haeckel prides himself, made as a passenger in an East India steamer, are, of necessity, like its phosphorescent track, somewhat superficial." It is considered that Haeckel's account of the distribution of the pelagic fauna and flora is premature, and as an accurate catalogue representing our knowledge is worthless. Prof. Agassiz points out that the number of new species constantly found by the tow-net of the 'Albatross,' when hauled from 200 fathoms to the surface, plainly shows that no reliance can as yet be placed on deductions drawn from the comparison of the contents of the nets at different localities and at varying depths. The deep-sea fauna of the Panamic district was found to contain a number of West Indian types or east coast forms, but it is not as rich as the West Indian. This comparative poverty is probably due to the absence of a great oceanic current like the Gulf Stream, which brings a large amount of food. Considerable attention was given to the coloration of deep sea forms, and it is interesting to note that there is much diversity.

* Bull. Acad. Roy. de Belgique, lxii. (1892) pp. 89-135.

† Bull. Mus. Comp. Zool., xxiii. (1892) pp. 1-89 (22 pls.).

Natural History in La Plata.*—Mr. W. H. Hudson's book, which is not so strictly limited to the Vertebrata as are many works written by those who are best known as ornithologists, is one of the most interesting books that has been published for several years. No lover of Natural History should fail to read it.

Comparative Pathology of Inflammation.†—Prof. E. Ray Lankester has an appreciative review of Prof. Metschnikoff's latest work ‡ in which he gives a "clear account of his phagocyte theory, tracing the significance of amœboid cells or phagocytes from the Protozoa upwards through various groups of animals to the higher Vertebrates." Inflammation is shown to be essentially a reaction of the phagocytes contained in animal bodies to the presence of injured tissue or intrusive particles. Prof. Lankester thinks the work will establish on a solid basis the doctrine of phagocytes, which he ranks with Virchow's cellular pathology and Pasteur's doctrine of the bacterial origin of fermentations and infective diseases. It is urged that the study of the lower animals is capable of furnishing us with the key, as it were, to those complicated pathological phenomena which are most interesting for medical science. Examples of parasitic infection among Infusoria are described, and "chemiotaxis" is shown to be characteristic of amœboid protoplasm. The reaction of mesodermic phagocytes of various Metazoa to foreign matters is described, numerous instances are given of bacterial and fungus diseases in Arthropoda, and the action of phagocytes in combating the intrusive parasites by ingulfing and digesting them is demonstrated. A detailed study is made of the leucocytes of the blood and lymph of Vertebrates, which are distinguished as lymphocytes, uninuclear, eosinophil, and neutrophil or multinuclear leucocytes.

B. INVERTEBRATA.

Phagocyte-organs of Invertebrates.§—M. L. Cuénot has made experiments on phagocytosis in some Invertebrates. He injected into the cœlom of vigorous and well-fed animals a varying quantity of fresh defibrinated mammalian blood. The red blood-corpuscles are absorbed by the phagocyte-organs when such exist, and give them an intense colour, which reveals them at once, when the animal is dissected. In Pulmonate Gastropods these red corpuscles are chiefly found in the connective tissue filled with large vesicular cells (cells of Leydig); these cells digest the foreign corpuscles. In the Crayfish the branchial glands become intensely red after the injection. In the Insects examined no phagocyte-organs were found; the injected corpuscles remain in the blood, and the animals die in a few days. Though *Asterias rubens* and *Echinus miliaris* have no phagocyte-organs, these animals are capable of resisting the injection of considerable quantities of blood, for the amœbocytes seize these corpuscles and free the organism of them.

* 'The Naturalist in La Plata,' London, 8vo, 1892, 383 pp., illustrated.

† Nature, xlv. (1892) pp. 505-6.

‡ 'Leçons sur la Pathologie comparée de l'Inflammation,' Paris, G. Masson, 1892.

§ Arch. Zool. Expér. et Gén., x. (1892) pp. ix.-xi.

Blood of Invertebrates.*—Dr. A. B. Griffiths gives an account of the amount of gas found in the blood of various Arthropods and Molluscs; a portion of the oxygen and carbonic anhydride present was found to combine chemically with some constituent or constituents of the blood. Copper plays in the blood of Invertebrates a similar rôle to iron in the blood of the higher Vertebrata. Although hæmoglobin is present in the blood of many Invertebrates, the chief constituent in most is hæmocyanin, which contains copper instead of iron.

Chemical Composition of Hæmocyanin.†—Dr. A. B. Griffiths precipitated hæmocyanin from the blood of *Homarus*, *Cancer*, and *Sepia* by sulphate of magnesium; he finds it has a very uniform composition, which may be indicated by the formula $C_{867}H_{1363}N_{223}CuS_4O_{258}$.

Mollusca.

Morphology of Mollusca.‡—The only subject dealt with by Herr J. Thiele in this communication is the epipodium of the Mollusca; a considerable part of it is devoted to a criticism of the views of Dr. P. Pelseneer. He regards the epipodium as representing an organ of the lateral line which is homologous with that of the Polychæta.

a. Cephalopoda.

Observations on a Living Argonaut.§—Prof. H. de Lacaze-Duthiers gives a very interesting account of some observations made of a living Mediterranean Argonaut which was kept in captivity at the "laboratoire Arago" at Banyuls. When brought to the laboratory the animal dropped its shell, but this was put into the aquarium with it, and the Argonaut soon took it again, mounted to the surface of the water, and remained there till it died. It was easy to push the creature under the water, but as soon as the pressure was removed it came again to the level, just below which it kept its body, inclined a little downwards and forwards. The eye has something feline about it. The changes of colour are not nearly so marked as in the Squid and the like. The funnel, seen from the side, looks like a muzzle. The author enters into a number of details, most of which tend to show that the earlier accounts of the Argonaut are of the nature of a fable.

Muscle-fibres of Cephalopoda.||—Dr. E. Ballowitz has in this connection investigated *Eledone moschata* and *Sepiola Rondeletii*, using also for comparison a number of other Cephalopods. The mantle, the pharynx, the arms, and the suckers were especially investigated. The fibres are very long and narrow, usually more or less flattened. In the middle of each there is usually a large oval nucleus. A completely tubular cortical portion of variable thickness is distinguishable from a granular axial portion. In the cortex there are continuous spiral lines surrounding the medullary substance, and traversing the whole thickness of the rind. In contraction the shape and the disposition of the spirals

* Proc. Roy. Soc. Edinb., xviii. (1892) pp. 288-94 (1 fig.).

† Comptes Rendus, cxiv. (1892) p. 496.

‡ Zeitschr. f. Wiss. Zool., liii. (1892) pp. 578-90 (1 pl.).

§ Arch. Zool. Expér. et Gén., x (1892) pp. 37-56 (1 fig.).

|| Arch. f. Mikr. Anat., xxxix. (1892) pp. 291-324 (2 pls.).

are altered. The spiral fibres are not simple, but are made up of very fine fibrils united by a resistant cementing substance. The spirals often present a granulated appearance, which seems due to the inswathing intermediate substance—in fact, to a likewise spirally disposed sarcoplasm. The granular accretions may be termed “sarcosomes” in the sense in which Retzius used that term. On the whole, these spiral muscle-cells are closely analogous to the cross-striped type. Ballowitz also describes the network of axial sarcoplasm, in which numerous granules are imbedded.

γ. Gastropoda.

Asymmetry of Gastropoda.*—Prof. A. Lang attempts to explain the asymmetry of Gastropoda in a manner which can hardly be made intelligible without a reproduction of his explanatory diagrams. He regards the explanation of Bütschli as incomplete, and considers that it is the development of a high turritiform shell which is the prime cause of the conversion of a crawling Gastropod into an asymmetrical animal.

Boring Organ of Natica.†—Herr P. Schiemenz asks, and seems to have succeeded in answering an old question, “How does *Natica* bore holes in mussel-shells?” By many arguments he shows that the round holes cannot be made by the radula. On the under surface of the proboscis, however, there is a complex circular gland, with an enormously developed glandular layer, and with one system of muscles so disposed that they certainly do not form a sucker, but in all likelihood simply compress the gland. As *Natica* bores its victims under cover of sand and cannot be directly observed, it is not certain that this gland is the boring organ, but it has an acid secretion (perhaps sulphuric) and in shape and size it corresponds with the holes.

Nudibranchiata holohepatica porostomata.‡—Prof. R. Bergh gives an account of this group of Nudibranchs, which includes two families—Doriopsidæ and Phyllidiidæ—superficially very unlike, but structurally congruent. The former includes two genera—*Doriopsis* (60 sp.) and *Doriopsilla* (2 sp.), the latter four genera—*Phyllidia* (5 sp.), *Phyllidiella* (4 sp.), *Fryeria* (1 sp.), and *Phyllidiopsis* (3 sp.). Of all the genera diagnoses are given.

Nervous System of Heteropoda.§—M. P. Pelseneer has made a study of the nervous systems of various forms of Heteropoda, and finds that the pleural ganglia are fused with the cerebral, and that in all the visceral commissure is crossed. He gives some details, and points out that they agree with those exhibited by such streptoneural Gastropods as are nearest to the Heteropoda; this leads him to the conclusion that the Heteropoda are simply Prosobranchs whose external appearance has been modified by a pelagic life.

Embryology of Chiton.||—Mr. M. M. Metcalf has some preliminary notes on the development of the Chiton. Fertilization is effected in

* Vierteljahrsschrift Naturf. Gesell. in Zürich, xxxvi. (1891) pp. 339-71 (22 figs.).

† MT. Zool. Stat. Neapel, x. (1891) pp. 153-69 (1 pl.).

‡ Verh. Zool.-Bot. Ges. Wien, xlii. (1892) pp. 1-16.

§ Comptes Rendus, cxiv. (1892) pp. 775-7.

|| John Hopkins Univ. Circ., xi. (1892) pp. 79-80.

the water, and though the males show signs of sexual excitement, there is no sort of congress of the sexes. The eggs measure 0.2 mm. in diameter within their chitinous envelope; they are of a light pea-green colour, and the chitinous envelope has a pattern peculiar to each species. On the whole, the author's work confirms that of Kowalevsky, and, as he tells us, adds little to it. There may be only one or there may be three polar globules, but those in which there was only one were, perhaps, not fertilized. When segmentation has resulted in the formation of four cells these are not rounded, but elongated in the direction of the principal axis. A little later a larger blastocœle appears, which is not wholly obliterated during the later development. No twenty-two stage was observed, and it is possible that Kowalevsky's observation was made on an abnormal embryo. At four and a half hours gastrulation is complete; the velum shows an hour later, and at eight hours the veliger larva emerges from the egg-envelope.

8. Lamellibranchiata.

Morphology of Lamellibranchiata.*—Mr. J. H. Kellogg has a preliminary notice of his studies on Lamellibranchs. He has found muscle-fibres with a very distinct cross-striation in the auricle of *Ostrea virginiana*, where the striations are so large that there are but twenty in the space of .03 mm. The secretory epithelium of the byssus, in *Cardita borealis*, is made up of two distinct kinds of cells; the most numerous are cuboidal, and appear to be ciliated. At the inner angles of the deep secreting folds there are numerous clear, unstained cells, with faintly striated outer ends and indistinct boundaries. The walls of the blood-vessels in the byssus organ were lined by an endothelium.

The nephridium of *Pecten* has been observed to be a brood-chamber. The plate-like gills of *Yoldia* are able to contract themselves in a variety of ways, and very rapidly. These gills have the power of collecting food, which is effected with amazing rapidity. The author's observations on the structure of these organs differ considerably from those of Mitsukuri; the rib-like strands which the latter considered to be chitinous supports are regarded as being museles, the contractions of which effect the movements already mentioned. The thickened edge of the gill-plates of *Solenomya* are remarkable for having the outer cells all almost exactly alike; they are columnar and ciliated, and have a dense deeply-staining outer border. The gills of various other forms have been examined, and the author states some of the conclusions at which he has arrived. The single row of latero-frontal cells, described by Peck in *Anodon*, and the two single rows of *Dreissena*, were not found in any of the marine forms examined, with the exception of *Mytilus*. Here there is an outer single row on either side, and an inner compound row of lateral staining cells. The latter arrangement will probably be found to be the most usual in Lamellibranch gills. Gland-cells are present at the sides—seldom, if ever, in the middle—of the frontal region, and are, at times, found in other regions of the filament. The author believes that an endothelial lining of the blood-cavity of the filament or plate, between the chitinous layers, will be demonstrated in the majority of

* John Hopkins Univ. Circ., xi. (1892) pp. 80-3.

the Lamellibranchiata. He has certainly observed it in *Yoldia*, *Pecten*, *Mytilus*, *Anodon*, and *Venus*, and probably in *Arca* and *Ostrea*.

There appears to be an almost constant correlation between the aborted or absent foot and a thick mantle with no large blood-spaces, and also between a fully-developed locomotor foot and a mantle consisting mainly of immense blood-spaces. Very large mantle-chambers appear to be characteristic of those forms which are most active. When, as in the oyster, the breaking down of tissues and the need of aeration is reduced to a minimum, there is a very small branchial chamber. The author suggests that the plate-gill is homologous not only with the descending limb of a filament, as Mitsukuri suggests, but with both ascending and descending limbs, for the former is merely a continuation of the latter.

Molluscoida.

a. Tunicata.

Development of Vibratile Organ of Compound Ascidians.*—M. A. Pizon has studied the development of the so-called vibratile organ (olfactory organ of Hancock) in a number of different Compound Ascidians. He finds that it commences as a blind tube formed by a diverticulum of the primitive endodermic vesicle, and that it opens secondarily into the branchial vesicle, while its hinder part undergoes a more or less rapid atrophy. This is contrary to the view of Van Beneden and Julin, who describe it as being due to a buccal invagination, and consequently homologize it with the hypophysis of Vertebrates. Owing to its early appearance, M. Pizon thinks that we ought to regard it as eminently an ancestral organ, which had probably a very important function in the primitive forms of Tunicata. The variations which it exhibits during the development of an ascidiozoid, its progressive atrophy and its almost complete disappearance in the Didemniadæ, shows that, at the present day, it performs no important function.

β. Bryozoa.

General History of Marine Polyzoa.†—The Rev. T. Hincks continues his 'Appendix' to his 'Contributions towards a General History of the Marine Polyzoa,' and describes several new forms; the only new genus is *Heterœcium*, one of the Membraniporidæ, which is remarkable in that the true external œcium is not, as is usual, an appendage of the zoœcium, but an integral part of it.

γ. Brachiopoda.

Brachiopoda of the 'Travailleur' and 'Talisman' Expeditions.‡—MM. P. Fischer and D. P. Oehlert report on the sixteen species of Brachiopoda obtained in four dredging expeditions by the above-mentioned French exploring vessels. Of these species only two were found to be undescribed. The authors discuss the geographical distribution of the species, and the lessons to be learnt from them; to the most important of these we have already § called attention.

* Comptes Rendus, exiv. (1892) pp. 237-9.

† Ann. and Mag. Nat. Hist., ix. (1892) pp. 327-34.

‡ 'Expéditions Scientifiques du Travailleur et du Talisman . . . Brachiopodes,' 4to, Paris, 1891, 140 pp. (8 pls.).

§ See this Journal, 1890, p. 585.

Arthropoda.

a. Insecta.

Embryology of Insects.*—Herr N. Cholodkovsky, answering V. Graber's criticism of a former paper, maintains his position that the supra-oesophageal ganglion of *Blatta germanica* develops from three pairs of rudiments. He also adheres to his attempt to explain the different forms of the blastopore in insects.

Colours and Markings of Vanessa.†—Dr. F. Urech recalls his observation of the frequent resemblance between the colour of the urine and that of the scales in many butterflies. Since the chlorophyll eaten by the caterpillar is voided unchanged, only colourless or white substances being digested, the pigments in the scales and Malpighian tubes must be either analytic or synthetic products of the food. Like Schäffer, Urech finds that the different colours of the scales arise from a uniform origin (chromogen), thus the scales are at first dark reddish in *Vanessa urticæ*, quite white in *V. Io*. A list of about thirty species is given, showing the (frequently congruent) colours of urine and scales.

The progress of coloration in ontogeny affords useful aid in determining the phylogeny. In the ontogeny of the *V. Io* pupa the succession of colours is white, yellow, red, brown, and black; the predominant colouring of *Papilio* is bright yellow, of *Vanessa* yellow to brown-red, of *Hipparchia* brown to blackish, of *Apatura* dark-brown to black; but this order *Papilio*, *Vanessa*, *Hipparchia*, *Apatura* seems to be phylogenetic; thus there is a general correspondence between the ontogenetic and the phylogenetic succession of colours.

Development of Mantis religiosa.‡—M. H. Viallanes deals chiefly with the development of the central nervous system. He finds that it is entirely developed at the expense of a pair of ectodermal thickenings which extend from the procephalic lobes to the caudal extremity of the embryo. At the cephalic end the primitive ridges are widened and segmented into five lobes. The first, second, and third formed the so-called protocerebrum; the fourth the deutocerebrum; and the fifth the tritocerebrum. In the first of these the ectoderm thickens and then becomes delaminated into two layers, which soon separate from one another. The outer forms the compound eye; the inner layer the first protocerebral lobe. The ear-cells of the latter may well be called the gangliogenous-cells, for they indirectly give rise to the ganglionic cells, and, as soon as the first ganglionic cells are formed, they undergo degeneration. As the cells multiply they produce between them the fibrillar substance, which forms the central nodule of the protocerebral lobe, and is invested by a ganglionic cortex. The fibrillar centre becomes divided into three distinct regions—the internal layer, the external chiasma, and the external medullary mass. The ganglionic cortex is differentiated to form the internal layer of the ganglionic plate, and the different groups of ganglionic cells which send prolongations to the external medullary mass. At a relatively late period postretinal nerve-fibres are formed between the ganglionic layer and the optic plate,

* Zool. Anzeig., xiv. (1891) pp. 465-6.

† Tom. cit., pp. 466-73.

‡ Ann. Sci. Nat., xi. (1891) pp. 283-328 (2 pls.).

and establish a communication between these two parts. In the course of development the ganglionic layer migrates from the protocerebral lobe, where it arose, and passes behind the eye. In connection with this movement the fibres of the external chiasma elongate a good deal, while the postretinal fibres become shortened. After describing in detail the history of the succeeding lobes the author passes to the ventral chain. The primitive ridges form a swelling in each segment. These swellings become the seat of histogenetic phenomena identical with those which happen in the cerebral lobes. In the embryo there are fifteen distinct ganglia—three post-oral cephalic, three thoracic, and nine abdominal. The nerves are given off from the nerve-centres in the form of buds, which are rounded at their extremities; these grow peripherally. The azygos visceral nervous system is composed of three median ganglia connected with one another by an unpaired (recurrent) nerve. These ganglia are all developed at the expense of the dorsal wall of the stomodæum, which becomes invaginated in the middle line. The name of ectodermic intraganglionic ridge is given to a temporary structure which enters into the most intimate relations with the nervous system, though taking no part in its constitution. An invagination of the ectoderm near the optic plate insinuates itself between the internal and external medullary masses; it becomes constricted off from the ectoderm, and, later, undergoes degeneration.

Habits and Metamorphoses of *Emenadia flabellata*.*—Dr. A. Chobaut gives an account of the life-history of this parasite, and comes to the general conclusion that the Rhipiphoridae have two larval forms, which differ much from one another; the first is truly tri-unguiculate, the second is like that of other Coleoptera. *Emenadia* is parasitic on solitary wasps such as *Odynerus*, or *Eumenes*. Their parasitic habit, which is absolutely analogous to that of *Rhipiphorus paradoxus*, consists in entirely devouring the larva of their host, as soon as it has reached its complete development, and at the very moment when it is passing into the nymph-stage; this act it effects as an external parasite, though it has previously passed all its time as an internal parasite.

Structure of Larval Nervous System of *Stratiomys strigosa*.†—MM. Henneguy and A. Binet call attention to a curious arrangement in this Dipterous insect. Each ganglion of the nervous system, which is highly concentrated, is united to its neighbour by a pair of very short connectives; each connective is formed of a bundle of fibres, which is nearly cylindrical in form for part of its length; this form is not, however, retained in the fibrillar substance of each ganglion; the fibres separate and extend through the ganglion at different planes. At the point where the connectives penetrate there is a cell with a very distinct and very large nucleus. There are in each ganglion four of these "cells of the connectives."

From each cell a certain number of radiating fibres are given off, and some have several secondary branches; these fibres and fibrils are lost in the connective-tissue element of the connectives. The authors are unable to suggest what is the function of these special cells; they

* Ann. Sci. Nat., xii. (1892) pp. 97-112 (6 figs.).

† Comptes Rendus, cxiv. (1892) pp. 430-2.

appear to be of the nature of connective tissue. The future fate of the cells in the pupa and imago is to be described in a future communication.

Embryology of Chalcidinae.*—M. L. F. Henneguy finds that in the Hymenopterous genus *Smicra* the segmentation of the egg is total; a single embryonic membrane appears very early before the formation of the embryo, and by a process which is very different from that which gives rise to the amnion of other Insects. The egg undergoes a considerable increase in size during its development, owing to the remarkable elasticity of its chorion. The embryonic membrane follows the growth of the embryo; its cells attain a large size and do not multiply. When the embryo is well formed these cells break up and undergo fatty degeneration. The egg obtains by endosmosis from the blood of its host the elements necessary for its nutrition.

Articulation of Abdominal Ring in Hymenoptera.†—M. G. Carlet has discovered an articular membrane which, by its folds, forms a kind of zig-zag articulation between the rings of the abdomen of Hymenoptera; this is well developed in the Bee. This mode of articulation allows the rings to be pushed into or out of one another, by the folding or unfolding of the interannular membrane. It is this arrangement which allows of the respiratory movements in all Hymenoptera; while, in the Bee, it facilitates the accumulation of wax under the ventral arches, and aids in the protection and prehension of this substance by the insect.

The Genus Carabus.‡—Herr A. Morawitz describes two new species of *Carabus* from Central Asia, namely *Carabus (Cratocephalus) pupulus* and *Carabus (Tribax) eous*, and passes from these to a discussion of the large genus. He is forced to recognize several sub-generic divisions:—Carabi tribacogenici, including *Platycarabus*, *Plectes*, *Tribax*, *Damaster*, *Coptolabus*, *Acoptolabus*, and *Cychrocarabus*; Carabi cechenogenici, including *Iniopachus*, *Cechenus*, *Cathaicus*; Carabi procrustogenici, including *Pachystes*, *Procrusticus*, *Procrustes*, *Pseudoprocrustes*, and *Chaetomelas*. Of the Procrustes-group diagnoses are given.

Hypostigmatic Cells of Bombyx mori.§—SS. E. Verson and E. Bisson give a detailed account of the remarkable large cells which occur in groups under or near the abdominal stigmata of the silkworm. These cells are remarkable histologically, especially in the direct continuity between the nuclear plasma and a peripheral "aureole," and in the delicate striations on the protoplasmic processes which radiate from the nucleus outwards. The cells increase in size during the larval life, and the nuclei exhibit remarkable structural changes. It seems certain that the hypostigmatic cells are glandular, that their secretory activity exhibits rhythmical periodicity, and that the nucleus has an active and direct share in the process of secretion.

Dimorphism among Pemphigiidæ.||—M. Horvath shows that in *Tetraneura gallarum ulmi* there are parallel dimorphic series such as

* Comptes Rendus, cxiv. (1892) pp. 133-6.

† Tom. cit., pp. 766-7.

‡ Mélanges Biologiques (Bull. Acad. Imp. Sci. St. Pétersbourg), xiii. (1891) pp. 5-54.

§ Bull. Soc. Entomol. Ital., xxiii. (1891) 4-19 (2 pls.).

|| Comptes Rendus, cxiv. (1892) pp. 842-4.

Dreyfus and others have demonstrated in *Chermes*, &c. From the viviparous root-inhabiting form two series of descendants spring :—(a) The winged “sexiparous” or “pupiparous” form which in autumn returns to the elms and bears the sexual generation, and (b) an apterous series whose members remain on the roots and remain viviparous.

Larvæ of Parasitic Bees.*—Herr C. Verhoeff describes the relations between the larvæ of *Osmia leucomelæna* and those of the parasitic *Stelis minuta*. The mother *Stelis* lays its egg, before the mother *Osmia*, more or less deeply in the ball of food. The parasitic larva is hatched a little earlier than its victim. Both feed for a time on the food-ball from opposite ends. Gradually the parasite approaches the other larva, which it kills and eats. The *Stelis*-larva is then about twice the size of its victim. Herr Verhoeff watched the unequal combat, and describes it in detail. The parasite first destroyed the brain, and sucked it for half a minute; it then bit the middle of the body and sucked that. Some other equally interesting facts are noted.

Passive Stage in Development of Cæstridæ.†—Prof. F. Brauer discusses the period of remarkably slow growth which occurs in the life-history of some larval Cæstridæ. Thus, in *Hypoderma Diana* eight months may elapse between egg-laying and the appearance of larvæ in the epidermic cells. The same is true of *Cephenomyia*, whose life-history Dr. J. Csokor has recently helped to elucidate. Brauer recalls his discovery that the eggs of *Cestromyia*, &c., are not laid in the skin which the mother-insect was supposed to perforate with her ovipositor; they are laid on the skin or hairs, and the newly hatched larva bores its own way into the dermis. In the larva of *Cestromyia* the mouth-parts are much stronger than in the larval *Hypoderma*, and there is no passive stage. The observations of Cooper-Curtice on the ox-warble (*Hypoderma lineata*) of the United States are of much importance, and are discussed at length. The American observer found 200 larvæ in the œsophagus, 45 in the “first skin-stage” in the dermis, 150 in the second skin-stage, and 550 in the third. It seems that the new-born larvæ are licked off the skin, and occur normally in the œsophagus and in other internal parts, whence they probably find their way to the skin.

Ants and Plants.‡—Herr O. Warburg proposes to call myrmecophilous plants “myrmecophytes,” and also coins the words “myrmeco-symbiosis” and “myrmeco-symbiotic.” He divides myrmecophytes into “myrmecotrophie” forms which supply food to the ants, myrmecodomous forms which offer only shelter, and myrmecoxenous which afford both.

The author gives a convenient account of recent investigations, and discusses some special points. Thus, his observations on species of *Myristica* show that these plants are in an indirect way myrmecotrophie, for colonies of Aphides are kept in the cavities of the twigs; but as it is far from evident that the ants are in this case of any use, it is not justifiable to call *Myristica* myrmeco-symbiotic. It possibly represents a first stage towards a mutual partnership.

* Zool. Anzeig., xv. (1892) pp. 41-3 (1 fig.).

† Verh. K. K. Zool.-bot. Ges. Wien, xlii. (1892) pp. 79-84.

‡ Biol. Centralbl., xii. (1892) pp. 129-42.

Compound Nests and Mixed Colonies of Ants.*—Herr E. Wasmann—whose studies on ants have been often recorded in this Journal—has published a book on the "*Biologie*," i.e. Bionomics, Psychology, and History of Ant-societies, discussing especially the compound nests in which different species of ants live together more or less habitually, and those mixed colonies in which the different species are combined either as masters and slaves or as partners. In his ætiological discussion he excludes the possibility of intelligence being a factor in evolving these complex states, and regards all the activities as instinctive.

Ants and Acacias.†—Prof. C. Keller has demonstrated the myrmecophilous character of *Acacia fistula* of the Somali lands. This is the first recorded indubitable case of an Old World acacia with symbiotic ants. All the trees bear some basally swollen thorns. The swellings are white and intact when young, but when older become black and exhibit a small circular hole. They contain ants, which Forcl in an appended note names *Crematogaster Chiarinii*, *C. Ruspolii* sp. n., and *C. Acaciæ* sp. n. Observations of a kind now familiar to us show that these ants are useful partners of the acacias. Even if ants be absent, as in young plants which Schweinfurth reared from seed, the swellings appear, "as if an abnormality had through natural selection in adaptation to ants become quite normal," but the entrance to the hollow swellings is made by the ants. This acacia is important as a source of gum, which adds an interest to the symbiosis. Moreover, the ants seem to have a beetle-partner—*Paussus spinicola* sp. n. according to Wasmann, and the white swellings are mimicked in the cocoons which a spider fastens to the branches. Prof. Keller mentions another acacia, also from Somali, which possesses swellings in which he found no ants but only a small caterpillar.

Changes of Colour in *Schistocerca peregrina*.‡—M. Kunckel d'Herculais finds that this locust undergoes a series of changes in colour; before and after each ecdysis the pigment is first rose-coloured. It is very interesting to observe that after each moult and metamorphosis the excrement of the locust is rose-coloured. The tegumentary deposits are colourless when they are not black. The author supposes that the pigment is zoonerythrine or some derived substance.

Fossil Insects.§—Mr. S. H. Scudder has collected in two handsome volumes the numerous memoirs he has from time to time published on fossil insects; all Palæozoic Insects had, he says, both pairs of wings membranous, but by the middle of the Mesozoic period all existing orders of Insects were fully developed in all their essential features.

5. Arachnida.

Association of Gamasids with Ants.||—Mr. A. D. Michael has an interesting paper on this subject. He finds that one species of Gamasid usually associates with one or two special species of Ants only, or at least

* Münster i. W., 1891. See Biol. Centralbl., xii. (1892) pp. 123-6.

† Zool. Anzeig., xv. (1892) pp. 137-43.

‡ Comptes Rendus, cxiv. (1892) pp. 210-2.

§ 'The Fossil Insects of North America, &c.,' 2 vols. 4to, New York, 1891, 456 and 734 pp. See Geol. Mag., ix. (1892) pp. 128-32.

|| Proc. Zool. Soc. London, 1891 (1892) pp. 638-53 (2 pls.).

preferentially. Gamasids found in Ants' nests are very rarely to be found elsewhere; they usually abandon the nest if the ant does so. The two kinds of animals live on friendly terms, and the ants even show signs of taking care of the Gamasids. The latter, on their part, do not appear to kill or injure the ants or their young, though they will eat dead ants. The Gamasinæ are not improbably either scavengers or else messmates who share the feast off any insects which the ants may kill, but it is not known what the Uropodinæ feed on or what is the object of their presence in the nest.

Development of Lung-books in *Scorpio fulvipes*.*—Mr. M. Laurie suggests that the lung-books of Arachnida were probably derived from a series of paired plate-like appendages, but united in the middle line by a gradual fusion of their edges with the abdominal wall of the body. The most simple condition is probably to be found in the Eurypterid *Slimonia*.

New Sensory Organ in *Galeodes*.†—M. P. Gaubert finds at the ends of the palps and of the first pair of legs of *Galeodes barbarus* an organ which has not yet been described. About thirty chitinous tubes of the size of a hair, open at both ends, arise from the integument and penetrate into the interior of the tissue. The penetrating end is succeeded by a sphere, the diameter of which is twice that of the tube; it is hollow, and is followed by a short cylinder ending in a truncated cone. The whole is enveloped in a delicate hypodermic layer. The nerve which supplies this organ gives off fibres which have nucleated cells on their path. The author also describes the coxal scales which are placed on the second pair of legs, and appear to be tactile organs.

Tegonotus—a new Phytoid.‡—Prof. A. Nalepa describes this new genus of Phytoidæ. The body is broadest behind the cephalothorax and narrows gradually posteriorly; the cephalothoracic shield is strongly developed, and often constricted near its posterior margin; the dorsal setæ are short and usually distant from the posterior margin of the shield; the abdomen is covered dorsally with more or less broad half-rings, mostly smooth, often flattened ventralwards and finely striated and punctated; the dorsal surface of the abdomen is roof-like, or traversed by two shallow longitudinal grooves, or only slightly arched; the dorsal half-rings often extend over the pleura in tooth-like projections (sub-gen. *Oxypleurites*) or even in spines (*T. heptacanthus*); the limbs are weak; the anal lobes are usually small. The new genus is placed near *Phyllocoptes* Nal. The following species are described:—*T. carinatus* sp. n.; *T. (Oxypleurites) trouessarti* sp. n.; *T. fastigiatus* sp. n.; *T. (Oxypleurites) serratus* sp. n.; and *T. (Oxypleurites) heptacanthus* Nal.

Coxal Gland of *Phalangium*.§—Herr J. Lebedinsky finds that the coxal gland of *Phalangium opilio* develops entirely from the mesoderm, and that the ectoderm shares only in forming the external aperture.

* Zool. Anzeig., xv. (1892) pp. 102-5 (4 figs.).

† Bull. Soc. Zool. de France, xvi. (1891) pp. 211-2.

‡ Zool. Jahrb., vi. (1892) pp. 327-37 (1 pl.).

§ Zool. Anzeig., xv. (1892) pp. 131-7 (7 figs.).

There are only two parts—the funnel and the coiled canal—and both are derived from the mesodermic hemi-somites. Lebedinsky believes that the coxal glands of Arachnids, the antennary, shell, and coxal glands of Crustaceans and of *Limulus*, are all nephridia and thoroughly homodynamic. But perhaps they are not thoroughly homologous. They are derived either from the primary embryonic coelom or from the secondary coelom, and these are morphologically different. In fact the homology of the glands raises the problem of the homology of the mesoderm among Arthropods.

3. Crustacea.

Deep-sea Dredging in the Indian Sea.*—Prof. J. Wood-Mason and Dr. A. Alcock deal, in the present portion of their communication with higher Crustacea only; they establish the new family Psallidopodidæ for a genus of Decapods, but they give no indications of what they regard as the most nearly allied of known forms. Various species of Acanthophysidæ and Pandalidæ are described or noticed.

Accelerator and Moderator Nerves of Crustacea.†—MM. F. Jolyet and H. Viallanes have studied in the common Crab the arrangement of the nerve-fibres that accelerate and moderate the movements of the heart. The centre for the former is in the ganglion of the last maxilliped and first thoracic limb, and for the latter in the more anterior part of the sub-oesophageal mass. The cardiac nerve of the Lobster appears to be wanting in the Crab.

Blue Colouring Matter of Blood of Crustacea.‡—M. F. Heim finds that this colouring matter exists in a reduced and colourless, and oxidized and coloured state. The additional oxygen is easily removed by a vacuum, the passage of inert gases, heat, or reducing agents. Hæmocyanin is not the only albuminoid substance in the blood of Crustacea, there are also serum and paraglobulins. It is, therefore, useless to try and prepare pure hæmocyanin by dialysis. Copper cannot be considered as a constituent of the molecule of hæmocyanin, for it is wanting in about half the Crustacea. These are not the only points in which the author's results differ considerably from those of his predecessors, for he notes several important points of distinction between hæmocyanin and hæmoglobin.

Excretory Apparatus of Decapod Crustacea.§—M. P. Marchal has published a detailed account of his observations on the excretory apparatus of the Decapod Crustacea. He describes it as consisting of sacculæ, labyrinth, and bladder; the labyrinth is all that part of the gland which lies between the sacculæ and the bladder, and it may always be considered as derived from a sac which becomes complicated by the formation of traversing trabeculæ and septa. As a rule, there is no tubular portion following the sacculæ; this is a statement which is opposed to what is generally taught, but what is only a too hasty generalization of the results obtained from the lower Crustacea and from the Crayfish; the

* Ann. and Mag. Nat. Hist., ix. (1892) pp. 265-75 (2 pls.); pp. 358-70 (6 figs.).

† Comptes Rendus, cxiv. (1892) pp. 189-91.

‡ Tom. cit., pp. 771-4.

§ Arch. Zool. Expér. et Gén., x. (1892) pp. 57-275 (9 pls.).

labyrinth may be considered as the representative of this tube, which has become very short and much widened.

As may be gathered, the author considers that the structure of the excretory apparatus of the Crayfish is far from being typical, and is, indeed, exceptional amongst the Decapoda. It is very probable that the medium in which the creature lives is partly the cause of this difference; Grobben has remarked that the antennary gland of the marine *Cetochilus* has a very short tube, while that of the freshwater *Cyclops* has a tube of extraordinary length; so, too, among Annelids the marine Polychæta have short segmental organs, while those of Oligochæta and Hirudinea are very long. This rule, however, is not absolute, for in *Telphusa fluvialis* the excretory apparatus is not different from that of marine Crabs. There is a great variability in all, except the Brachyura, which form a very homogeneous group. In the Astacidae the septate, non-ramified saccule is free on its upper surface, while its lower is imbedded in the rest of the gland. The blood-supply comes from both the antennary and sternal arteries; in the Lobster the labyrinth seems to exhibit a tendency to elongate into a spongy cord, and this becomes much more obvious in the Crayfish. In the Galatheidæ, Thalassinidæ, and Paguridæ the saccule is ramified and enveloped by the labyrinth in which it is invaginated; the sacculus artery is the only important one, and serves to irrigate the gland. In the Palinuridæ the upper surface of the saccule has a villous or mammillated appearance, and the saccule itself is much ramified; the labyrinth opens widely into the bladder in such a way that, when its cavity is not traversed by trabeculæ, it seems to be a scarcely differentiated diverticulum. *Palinurus* has an appended gland. In the Carididæ the saccule is perfectly distinct from the labyrinth, or the latter is entirely absent.

The quantity of fluid excreted is very considerable; it contains homogeneous or refractive globules, vesicles, and a small amount of cellular debris. If the evacuation of fluid from a *Maia* be stopped the animal dies in from eight to fifteen days. The author distinguishes a carcinuric acid, which is allied to the carbopyridic acids, and this, joined to the presence of a leucomaine, as a normal and essential product of nitrogenous waste, is a remarkable and unexpected fact.

Embryology of *Homarus americanus*.*—Mr. H. C. Bumpus gives an account of the earlier stages in the development of the American Lobster. The eggs are normally deposited during the months of July and August, and develop rapidly so long as the water is relatively warm. The eggs are normally carried by the female from nine to ten months. The receptive apparatus of the female seems till now to have escaped detection. It lies at the posterior end of the sternum, and is a highly coloured heart-shaped body. The openings of the oviduct lie anteriorly, while a keel-like piece stands as a wedge between the wings, which are directed laterally and posteriorly. If these wings are forcibly depressed, a whitish substance is seen to ooze out between them and the keel; this fluid, when examined, will be found to be spermatic.

A full description is given of the ovary at various stages and of the ovarian egg; the egg is primarily ectolecithal, but later on becomes

* Journal of Morphology, v. (1891) pp. 215-62 (6 pis.).

somewhat telolecithal. In the descriptive portion the author makes such repeated references to his illustrative figures as to render it impossible to give a clear account of his observations without reproducing them. We may note that he has observed a nauplius-stage, in which the appendages are tipped with spines. As in several higher Crustacea, though not in *Astacus*, there is an ocellus. The author's descriptions cease at a stage which may be compared with the earliest figured by Mr. S. J. Smith.

Formation of Germ-layers in Crangon vulgaris.*—Prof. W. F. R. Weldon gives a detailed account of the formation of the germ-layers in this Crustacean; in many important points his results are quite at variance with those of J. S. Kingsley, though they are in accordance with the account given by Nusbaum of the corresponding process in *Mysis*. A discussion of the results arrived at is postponed till the author has carried his researches further.

Development of Diptychus.†—M. E. L. Bouvier has investigated the development of this Galathoid, and finds that it resembles in all essential points that of the Astacine Crustacea. The characteristic features in its development are the displacement of the arthrobranchs and the delay in the escape from the egg. Although this latter is not so great as has been supposed, the retardation is obviously favourable to the preservation and development of the species; it compensates for the inferiority which is due to the small number of eggs, and recalls, to a certain point, the history of *Hyla martinicensis* where the tadpole-stage is passed within the egg.

The Genus Glaucothoë.‡—M. E. L. Bouvier raises the question whether the forms placed in the genus *Glaucothoë* are not really Pagurine larvæ. He finds that such examples as have been considered perfect by certain carcinologists have no sexual orifices or ophthalmic scales, and the absence of these are larval characteristics. They are certainly Pagurine, and have only distant relations to the Thalassinidæ. They form a polymorphous group, and probably contain as many forms as there are genera of Paguridæ. The species as yet known are more allied to the asymmetrical Pagurids than the primitive Pagurids. The rarity of Glaucothoids of large size may be explained by supposing that large specimens are larvæ less fortunate than the rest, which continue to grow until they can find a suitable home. All the known forms of *Glaucothoë* are swimming creatures, found on the surface of the sea.

Early Stages in Development of Hedriophthalmous Crustacea.§—M. L. Roule signalizes the diffused origin of the mesoderm of these Crustaceans, which arises from almost the whole of the blastoderm. Another important fact is the double origin of the endoderm, the two original bands of which are separated by a large space. The combination of these two characters is truly characteristic, for they are not met with in the condensed developments of other Cœlomata. A phenomenon of great importance is exhibited by the archenteron, which is hollowed out

* Quart. Journ. Micr. Sci., xxxiii. (1892) pp. 343-63 (3 pls.).

† Comptes Rendus, cxiv. (1892) pp. 767-70.

‡ Ann. Sci. Nat., xii. (1891-2) pp. 65-82.

§ Comptes Rendus, cxiii. (1891) pp. 868-70.

without any previous gastrular invagination, and exhibits no signs of such an origin.

Cutaneous Glands with Intracellular Canals in Hedriophthalmate Crustacea.*—M. M. Ide is led by his study of these glands to some general considerations with regard to unicellular glands. He points out that in all the products are passed to the exterior without passing into any epithelial cavity, and that no intercellular passage is formed by the separation of the elements. The simplest glands are epidermal cells, or, to speak more generally, secreting epithelial cells scattered among ordinary cells, and passing their products directly to the exterior. The caliciform cell may be taken as the type of this rudimentary form. In certain cases the gland-cells are developed more than their neighbours, and their swollen internal part extends beyond the line of the epithelial rows. There is thus formed a neck which connects the cytoplasm with the exterior. This neck forms the canal of passage for the secreted products, and represents in a quite simple way the outer part of the cavity of a caliciform cell. The glandular ring on the cloaca of *Arion* presents remarkable examples of this form. In others the neck undergoes differentiation; it becomes chitinized or hardened, and then takes on a purely conducting function, while the elaboration of the secreted product is localized in the swollen portion. But differentiation may go still further. The secreting cavity ceases to be a simple lacuna of the cytoplasm, and its wall becomes like that of the neck; this is what may be seen in the intestinal canal of many Insects.

The cavity may be prolonged still further and fold itself irregularly, without subdivisions, as in Bees, or it may take on a digitate form, or become richly arborescent, as it is in the segmental organ of the Hirudinea. Fresh differentiations may yet be superadded, as by the appearance of a radiate vesicle surrounding the extremity of the internal canal, and the radiate sheath on the external portion of the canal, as in *Blaps mortisaga*. The odoriferous gland of this species appears to represent the highest known degree of the differentiation of the glandular cell.

This cell may, however, tend not only to be differentiated, but to be subdivided. The first indication of this is to be seen in the gland of the urostyle of the Oniscidæ, where a deep constriction divides the cell into two halves, each of which possesses a nucleus. In the glands of *Vibilia* there is not a mere constriction of the cytoplasmic mass, but there is a true segmentation, when three cells become formed. This subdivision goes still further in the glands of *Phronima*, where there are five distinct cells. The segmental glands of the Hirudinea appear to belong to the same type.

The products of secretion of the glands of the urostyle of *Oniscus* form exceedingly fine threads very like the silk of Lepidoptera and Spiders.

Development of *Oniscus murarius* and *Porcellio scaber*.†—M. S. Jourdain deals particularly with the development of the appendages of these two Isopods, and with the so-called dorsal organ. The egg becomes provided with an epiblastic shield formed of columnar elements; it then elongates, and the ventral plate becomes divided by a groove into

* La Cellule vii. (1891) pp. 347-73 (2 pls.).

† Comptes Rendus, cxiv. (1891) pp. 428-30.

two equal halves. This groove is, in its turn, cut perpendicularly to its length by parallel incisions, which divide it into twenty-one bands, at the outer margin of which a bud soon appears. This bud is the first indication of the appendages; at first, all the bands and all the buds are exactly similar, with the exception of the foremost, which is provided with cephalic discs.

Soon differentiations are seen in the buds, and three groups can be distinguished; the cephalic is composed of seven pairs of buds; the thoracic has seven; and the ventral has the last seven. As the author regards the cephalic plates as the first somite, and as they bear the ocular cones, he looks on them as oculiferous limbs which remain rudimentary.

The egg has an outer membrane or chorion, below which there is a second and much more delicate layer or deutovum; below this there is what appears to be an amniotic sac, but it does not completely envelope the embryo; it is only developed on the dorsal surface, and it is this which has been taken by embryologists for a special organ.

Development of Amphipoda.*—Madame C. Wagner devotes the fifth memoir on the development of Amphipoda to *Melita palmata*. In many points of external development the history is the same as that of *Gammarus* and *Caprella*, but this is not the case as to the development of many of the internal organs. Though most of the ectodermal cells are much flattened there is in the middle of the back a group of very large cells, which represents the foundation of the dorsal organ; the cells of this group are at first amoeboid in form, but later on they elongate, and in transverse section are seen to have a fan-shaped disposition. Each ganglion of the ventral chain is developed independently and there is no fusion to form a chain until after the complete development of the central dotted substance; it is for this reason that the commissures are only formed of the central nervous mass.

The endodermal cells early form two symmetrical bands on each side of the middle line of the embryo; towards the oral pole, however, and a little below the equator of the egg the two bands seem to be fused; the endodermal elements multiply with great rapidity, and at either end there is formed a cul-de-sac; these represent the foundations of the two hepatic sacs.

Antennary Gland of Orchestiidae.†—M. J. Bonnier remarks that the sole justification for separating the Orchestiidae from the rest of the Gammaridea, and calling them Saltatoria as opposed to Natatoria, is the absence of the antennary gland. This organ, however, is present, and G. O. Sars is justified in his suggestion that the Orchestiidae should be considered as merely a subdivision of the Gammaridea.

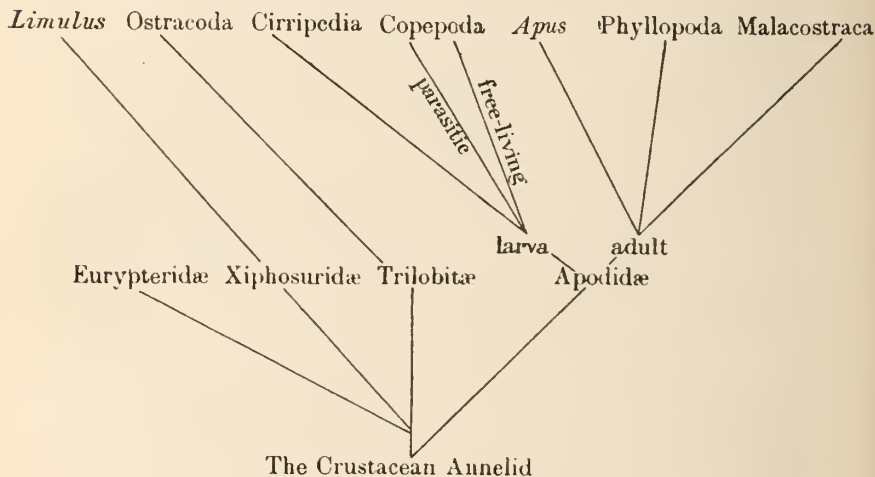
Reproduction of Cirripedia.‡—M. A. Gruvil finds that the ordinary method of fecundation in Cirripedes is reciprocal; when this is impossible there may be self-fecundation. There is no true copulation, but merely an apposition of the sexes and deposit of the sperm near the oviducts. In *Pollicipes* there appears to be merely self-fecundation.

* Bull. Soc. Imp. Moscou, 1891 (1892) pp. 401-9 (2 pls.).

† Comptes Rendus, cxlii. (1891) pp. 808-10.

‡ Tom. cit., pp. 706-8.

The Apodidæ.*—Mr. H. M. Bernard, struck by the resemblance between the organization of *Apus* and that of a carnivorous Annelid, has investigated the Apodidæ in order to discover whether this resemblance was due to homology or analogy. He works out in detail the possibility of the derivation of the Crustacea from Annelids, and he “uses *Apus* as a key to solve the hitherto unsolved problems as to the origin of the Crustacea, and the true affinities between the various groups.” In the second part of his work appeal is made to the palæozoic Crustacea, and the conclusion is reached that, if *Apus* is to be derived from a carnivorous Annelid, a similar derivation must be allowed for the Gigantostroaca.



The author exhibits his views as to the relationship of *Apus* to the rest of the Crustacea in the accompanying scheme.

Vermes.

a. Annelida.

Compound Eyes of Annelids.†—Mr. E. A. Andrews, who has already ‡ published a preliminary notice of his investigations, now deals in detail with the eyes of *Potamilla* and *Sabella*. Those of the former are numerous cones of modified epithelium of the main stems of the cephalic branchiæ; each is composed of elongated, pigmented cells, a few of which have peculiar refracting bodies in their outer ends and modified axial parts. These, which may be presumed to be the sensory cells, have pigment only in the superficial part of their protoplasm. As each sensory element is separated from its neighbours by intervening pigment-cells such an eye is compound. In a species of *Sabella* and of *Dasychone* the eyes have essentially the same structure; in one of *Hypsiocomus* the branchial eyes are not compound, but are comparable to one of the elements of the just described eye.

* 'The Apodidæ,' London, 8vo, 1892, 316 pp. and 71 figs.

† Journal of Morphology, v. (1891) pp. 271-99 (2 pls.).

‡ See this Journal, 1891, p. 738.

Previous investigations show that eyes such as those now described are widely distributed among the Sabellidæ and Serpulidæ, but most of the observations were too superficial to admit of detailed comparisons as to cell-structure. They are all too simple in structure to admit of any direct comparison with the eyes of Arthropods; with the eyes of certain Mollusca, however, they exhibit close agreement. The protuberant mantle organs of the Lamellibranchs *Arca* and *Pectunculus* have quite the same structure as those of these Annelids, save with regard to the sense or refractive cell. There does not appear, in Molluscs, to be any specialized axial region external to the nucleus, but there is a peculiar conical body which occupies the apical part of the cell.

In both sets of forms the animals respond very quickly to slight sudden changes in the intensity of illumination. The occurrence of stiff hair-like processes upon these organs raises the suspicion that some other sense organ in addition to or in place of an eye may be here concerned. The great number and position of the organs suggests doubts as to their usefulness as eyes. And, finally, much of our present evidence is very dubious; *Hydroides dianthus*, which has no eye-like branchial organs, nor, so far as is known, any other special sense-organs, responds fully as well to very slight shadows passing over it as does *Potamilla*.

Siphonostoma diplochætos.*—Mr. E. J. Bles has some observations on the structure of this Polychæte, in which he has been able to detect the nephridial funnels which escaped previous observers. He is inclined to believe that this form is really a modified tubicolous worm, which has secondarily acquired an errant habit.

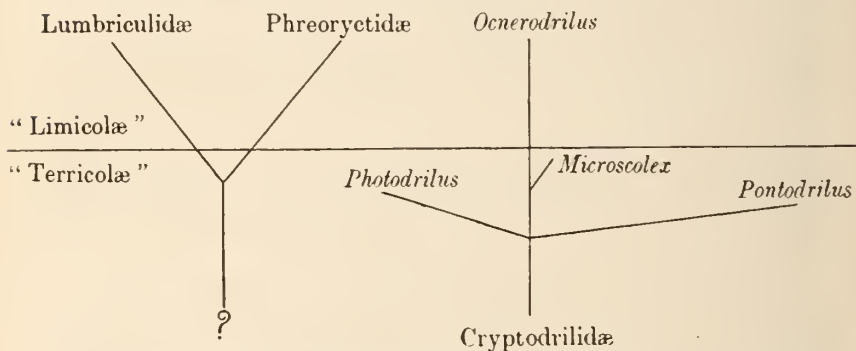
New Branchiate Oligochæte.†—Mr. F. E. Beddard describes a new genus of branchiate Oligochæta, to which he gives the name of *Branchiura Sowerbyi*; it was found in some mud from the "Victoria regia tank" in the Botanical Society's Gardens, London. It is remarkable for having at its hinder end a series of delicate dorsal and ventral processes. These last, which give a feathery appearance to the hinder part of the body, number about fifty pairs, one pair to each segment. In *Chætobranchus*, a form recently described by Prof. A. G. Bourne, the branchiæ are anterior in position, and there is a connection between the setæ and the branchiæ which does not exist in *Branchiura*. In the latter the branchial process arises in the middle dorsal and ventral lines; the structure of these processes is very simple; they are covered by a firm cuticle, beneath which lies the epidermis; no cilia were detected on them. The axis of the branchia is occupied by a cavity which evidently belongs to the coelom. Immediately beneath the epidermis is a layer of muscles which appears to be continuous with the circular layer of the body-wall, and beneath this is the peritoneum. Immediately beneath the epidermis there is on each side a blood-vessel. In addition to this there is an extensive integumental network of capillaries. After describing other anatomical details, the author points out that *Branchiura* is evidently one of the Tubificidæ, but it is nearly equally remote from all the genera at present comprised in that family.

* Rep. Brit. Ass., 1891 (1892) pp. 373-6.

† Quart. Journ. Micr. Sci., xxxiii. (1892) pp. 325-41 (1 pl.).

Anatomy of *Ocnerodrilus*.*—Mr. F. E. Beddard takes the opportunity of having discovered a new species of this interesting genus from British Guiana, which he calls *O. Eiseni*, to give an account of its anatomy. He is led to the conclusion that it is necessary to form for it a distinct family (*Ocnerodrilidæ*), which may be defined thus:—Small *Oligochæta* with paired setæ of lumbricid pattern; testes two pairs in segments x. and xi.; vasa deferentia open on segment xvii. in company with an atrium lined by a single layer of cells, and divided into a glandular and non-glandular portion. Ovaries paired in segment xiii.; oviduct open on xiv.; ova moderately large; septal glands, but no gizzard; a single pair of glandular diverticula of œsophagus in segment ix.; nephridia abortive in some of the genital segments, and, in the posterior region of the body, imbedded in a mass of large vesicular peritoneal cells.

The relationship of this to allied forms is represented in the diagram.



New Genera of Aquatic *Oligochæta*.†—Mr. F. E. Beddard gives an anatomical description of two new genera of aquatic *Oligochæta* from New Zealand, which he calls *Phreodrilus* (*P. subterraneus* sp. n.) and *Pelodrilus* (*P. violaceus* sp. n.). The first of these does not fit in perfectly with any one of the known families of the group, and the author, therefore, institutes for it a new family—the *Phreodrilidæ*. It is characterized by having the setæ in four rows; the dorsal setæ being long and capilliform, two to each bundle in the anterior and one in the posterior segments. The ventral setæ are of two kinds—one of each being in each row—curved and S-shaped without a notched extremity. The testes are in segments x. and xi., and form a continuous mass on each side, perforating the intermediate septum. The long atrium, somewhat like that of the *Tubificidæ*, has no prostate or penis; the whole of the alimentary tract, with the exception of the buccal cavity, is ciliated, as in *Phreodrilus*, the *Naidomorpha*, and other lower families of the *Oligochæta*.

Pelodrilus appears to be one of the *Phreoryctidæ*, but it is more like the Earthworms than is *Phreoryctes* itself, and it serves to link more closely the family in which it is placed with the higher *Oligochæta*.

* Trans. Roy. Soc. Edinb., xxxvi. (1891) pp. 563-83 (1 pl.).

† Tom. cit., pp. 273-305 (3 pls.).

Earthworms from Ecuador.*—Dr. W. B. Benham gives a detailed account of a new Earthworm, collected by Mr. E. Whymper, which he calls *Rhinodrilus ecuadorensis*. The locality at which this species was taken is interesting, as it is from Cayambe, at a height of 14,000 feet. The author takes the opportunity of correcting some mistakes of preceding anatomists.

Ciliated Organs of Hirudinea.†—Prof. H. Bolsius commences his treatment of this subject by dealing with the ciliated organs of *Nepheleis*. He comes to the conclusion that, if their organs have the same morphological significance as in Chaetopods, they have certainly very different anatomical relations, and quite another function. He cannot consider that the ciliated organs should be regarded as the terminal infundibula of segmental organs. They are not funnels, for they are cupuliform and have an imperforate base; and they do not form the ends of the segmental organs. Moreover, they are anatomically separated from the segmental organs by the interposition of other organs.

As to the functions of these ciliated bodies the author offers two suggestions. They may take part in keeping up the circulation of the blood in the vessels; this they would effect by means of their long cilia. Or, it is possible that they are the points at which the wandering cells of the blood are formed.

These organs may be shortly described as small cups, the edge of which is particularly formed by large ciliated cells, which are simple in the young and bilobed in the adult. They have an imperforate floor formed of non-ciliated cells. They are suspended by connective cells of varying form to the walls of a spacious capsule or vesicle, in such a way that the liquid of the vesicle bathes them all round. The capsule itself has a delicate, non-contractile wall, formed of a single layer of cells. The ciliated organ and its capsule have no connection with the excretory organ.

Sensory Corpuscles and Cutaneous Glands of Unarmed Gephyrea.‡—Prof. E. Jourdan has investigated the sensory corpuscles which are scattered over the whole surface of the body of *Sipunculus nudus*; varying in number in different regions, they are most abundant near the hinder extremity, but in all cases they have the same structure; they are formed of epithelial cells, which are evidently derived from the general epithelium of the walls of the body, and they are so grouped as to form a distinct corpuscle. The peripheral end penetrates a large cuticular pore, and in this the free ends of the cells are brought to the surface. As to their minute structure there is, in the centre of the corpuscle, a bundle of very delicate fibrillar cells, comparable in their general appearance to the olfactory rods or central gustatory cells of Vertebrates. The bundle of rods ends near the surface of the cuticle at the level of a small crateriform depression; at the base of this there are some short hairs which appear to be rather protoplasmic structures than rigid cuticular hairs. These central elements are sensitive, and are surrounded and protected by gland-cells, which are easy to distinguish

* Ann. and Mag. Nat. Hist., ix. (1892) pp. 237-46 (1 pl.).

† La Cellule, vii. (1891) pp. 291-321 (2 pls.)

‡ Ann. Sci. Nat., xii. (1891) pp. 1-14 (1 pl.).

on account of their homogeneous contents and yellowish-brown colour. In addition to the elements directly derived from the epithelium there are others which are shown by their position and structure to be nervous. At the base of each sensory organ there is a nerve-fibre, connected with a plexus which lies in the connective tissue; these fibres appear to be feebly differentiated as compared with the nervous elements of Vertebrates.

The cutaneous glands of *Sipunculus nudus*, which are scattered over the whole body, are specially numerous on the proboscis, and least numerous near the hinder end of the body. There is considerable variety in the form and contents of these glands, but there is no doubt that they are all derived from the general epithelium. They are all coloured pale rose by alum-carminé after treatment with osmic acid. The whole surface of the body of *Phascolosoma elongatum* is covered by small warty projections, and the glandular or sensory elements are found in one and the same follicle. Each of these organs is formed of a cavity hollowed out in the cuticle and lined by flattened epidermic cells, similar to those of the rest of the body. They are in connection with the subjacent layers by a hollow pedicle; in the lumen of the canal there are one or more nerve-fibres.

In conclusion, a short account is given of the sensory and glandular corpuscles of *Aspidosiphon scutatum* and *Phascolion strombi*. The general surface of the body being sheltered by the walls of old tubes of Serpulæ or shells of Molluscs is less sensitive than in the preceding forms; the proboscis, on the other hand, is a very delicate sensory organ; its sensory corpuscles are formed by groups of small rod-shaped cells, but the author was unable to trace any nerve-fibres into them.

Echiurus chilensis.*—Dr. A. Collin describes the original specimen in the Berlin Museum to which Max Müller referred in 1852. It is a distinct species, and the title *Echiurus chilensis*, which has found a place in the literature of Echiuridæ, should be retained. The species need not be described here, save in so far as that is done in saying that it closely resembles *Ech. uncinatus* v. Drasche except in its large size ($6\frac{1}{2}$ in. in length), and in having three pairs of segmental organs.

β. Nemathelminthes.

Development of Gordius.†—M. A. Villot gives a general, historical, and critical account of the development of *Gordius*, a subject to which he has devoted much attention. He finds that everything tends to demonstrate the truth of his original statement that *Gordius*, like *Mermis*, is developed in one host only; he would, indeed, go further and affirm that the encystation of the embryo is not a necessary phase in the development of this form. In the history of the second or larval stage there is nothing which can be compared to the process of alternation of generations. The development is a true metamorphosis, not without analogy to that which is seen in *Mermis* and *Echinorhynchus*. *Gordius* has, however, not had its primitive organization so profoundly modified by

* Zool. Anzeig., xiv. (1891) pp. 463-4.

† Ann. Sci. Nat., xi. (1891) pp. 329-401 (3 pls.).

parasitism as they have. The most remarkable peculiarity of the larva of *Gordius* is the very precocious development of the genital organs.

Life-history of *Filaria papillosa*.*—Herr Deupser has made many endeavours to trace the life-history of this Nematode parasitic in the serous cavities of the horse and ox. As yet little success has attended his experiments, except that he found small forms in most respects like the embryos of *F. papillosa* living in the blood of the horse. In 1849, Wedel also found *Filaria* in the horse's blood, but of this Deupser was unaware until after he had discovered the fact independently. Deupser also found that the horse's blood was the medium in which the embryos of *F. papillosa* could be kept alive for the longest time, and he succeeded in finding them in the blood of rabbits, into whose abdominal cavity he had introduced several pregnant females. Therefore, it seems that *F. papillosa* resembles *F. Bancrofti*, *F. attenuata*, and *F. tricuspis*, but no clue as to the intermediate host was found.

Monograph of *Dispharagus*.†—Dr. M. Stossich has a monograph of this genus of Nematodes which he divides into a group (containing two species) with an armed body, and a group of twenty-four species, which are spineless. Nine species require further investigation. All the known forms live in the œsophagus and stomach of Birds.

***Strongylus rubidus*.**‡—Mr. A. Hassall and Dr. C. W. Stiles give an account of a small nematode which has lately been found, sometimes in great abundance, in the stomachs of pigs slaughtered at Washington. The male is 5 mm., the female 8 to 8·5 mm. long. When present in large numbers there was an excess of thick mucus in the stomach.

Nephridia of *Acanthocephala*.§—Dr. J. Kaiser has directed his attention to the two disc-shaped bodies connected with the dorsal ligament, not far from the genital orifice, in *Echinorhynchus gigas*. By carefully removing them, together with the uterine bell, from the body of a female of this species, and examining in a drop of the coelomic fluid, he was able to detect the undulation of a broad ciliary flame in each of the numerous cylindrical terminal pieces of this enigmatical organ. The flames are composed of a large number of parallel, thin cilia, and are in a state of constant undulation. There can be no doubt as to the nephridial function of the organs in question; in connection with the three vascular spaces which rise in the walls of the bell they form an excretory organ, which is adapted to remove nitrogenous waste, and to pass it from the coelom into the uterus. By the contraction of the uterine tube the waste matters are passed to the exterior.

The author calls attention to the resemblances which these organs offer to the nephridia of the Platyhelminthes. Branched nephridial canals are not only found in the Nemertinea, but also in the head-kidneys of the larva of *Polygordius* and Echini; the permanent nephridia of *Bonellia* may be put in the same category, and the author thinks that the excretory tubes of *Acanthocephala* may be more easily derived from

* Zool. Anzeig., xv. (1892) pp. 129-31.

† Boll. Soc. Adriat. Sci. Nat. Trieste, xiii. (1891) 3 pls. See Centralbl. f. Bakteriöl. u. Parasitenk., xi. (1892) pp. 448-9.

‡ Journal Comp. Medicine and Veterinary Archives, April 1892, 3 pp. (3 figs.) (sep. copy). § Centralbl. f. Bakteriöl. u. Parasitenk., xi. (1892) pp. 44-9.

the nephrostomes of the Annulata than from the glandular ciliated cells of the Platyhelminthes.

Hosts of Echinorhynchus proteus.*—Dr. O. Hamann brings forward evidence to show that this parasite does not always pass its larval stage in *Gammarus pulex*, but that at this stage it may infest the liver of various fishes, such as *Cottus gobio*, *Gobio fluviatilis*, *Gastrosteus aculeatus*, in the intestine of which it lives when mature.

Helminth Larvæ.†—Dr. v. Linstow has notes on *Ascaris Pterostichi*, *Filaria Gammari*, *Filaria Ephemeridarum* spp. nn., *Angiostomum macrostomum* v. L., *Trichosoma Bombinatoris*, *Nematodum Gamasi* spp. nn., *Mermis crassa* v. L., *M. Gammari*, *M. Sialidis* spp. nn., *Gordius tolosanus* Duj., *Echinorhynchus polymorphus*, *E. proteus*, *Cercaria Linnæa truncatula* sp. n., *Distomum endolobum* Duj., *D. Pulicis* sp. n., *D. Sialidis* sp. n., *D. echinatum*, *Gyrodactylus elegans* v. Nord.; and eight species of *Cysticercus* including *Cysticercus Tæniæ pachyacanthæ* sp. n. and *Cysticercus Lacertæ* sp. n.

γ. Platyhelminthes.

Terminations of Excretory Apparatus of Nemertinea.‡—Herr O. Bürger finds that the canals of the nephridial apparatus of Nemertines are provided with a ciliated epithelium, and end in hollow blind swellings, which are also invested in a unilaminar multicellular epithelium. Attached to the blind thickened end of each swelling there is a "flame" which swings into the lumen of the swelling.

Bipalium Kewense.§—Mr. A. E. Shipley has a note on this imported worm, which has lately been found near Bath. He confirms Bell by saying that strong sunlight is harmful and often fatal to it. He describes the urticating organs as containing threads which do not, like those of *Hydra*, stretch straight out, but assume a somewhat coiled disposition; and he suggests that the rhabdites, so common in Turbellaria, may be derived from the basal part of the flagellated structures.

Minute Structure of Trematoda.||—Dr. G. Brandes communicates some of the results of his studies on the minute anatomy of these worms. Cutis, epidermis, limiting membrane, dermal layer, cortical layer, basement membrane, sistema tegumentaris, investing membrane, cuticle and pseudocuticle are all names for one and the same tissue in Trematodes; and they show how varied have been the views of investigators. After discussing some of these the author tells us that there is no subcuticle in the ordinary sense of the word; what is generally so called is nothing more than a part of the parenchymatous connective tissue; the outer covering of the body is, however, a true cuticle, and is the product of the dermal glandular layer which is present in all Trematodes. The author gives a detailed account of what he has been able to observe in *Amphistomum conicum*, and shorter notes of the characters presented by other forms.

* Centralbl. f. Bakteriöl. u. Parasitenk., x. (1891) pp. 791-2.

† Arch. f. Mikr. Anat., xxxix. (1892) pp. 325-43 (1 pl.).

‡ Zeitschr. f. Wiss. Zool., liii. (1891) pp. 322-33 (1 pl.).

§ Proc. Cambridge Phil. Soc., vii. (1892) pp. 142-7.

|| Zeitschr. f. Wiss. Zool., liii. (1892) pp. 558-77 (1 pl.).

Ectoparasitic Trematoda.*—Herr C. Diechhoff commenced his investigations on the ectoparasitic Trematodes with a view of solving the question raised by Ijima as to the existence of a connection between the female generative apparatus and the digestive tract in ectoparasitic trematodes; but it has extended itself to an investigation into the anatomy of *Octobothrium lanceolatum*, *O. Merlangi*, and *Polystomum ocellatum*.

The author finds that in *Polystomum integerrimum* the vitello-intestinal canal is a structure which it is difficult to overlook; the wall consists of connective tissue invested by epithelium with a moderately large number of nuclei; the canal is found either empty or filled with sperm or yolk substance. Its connection with the enteric wall is very peculiar for it runs for some distance beside it, and then enters at an angle in such a way as to form a cup-shaped projection. By this arrangement the compression of the intestine prevents the entrance of the enteric contents into the genital ducts. The arrangements of the canalis vitello-intestinalis in *P. ocellatum*, *Octobothrium Merlangi*, *O. lanceolatum*, *Diplozoon paradoxum*, *Axine belonis* are next described, and the existence of this connection between the enteron and genital duct safely established.

Detailed accounts are then given of the anatomy of the already-mentioned Trematodes.

Vitelline nuclei of Distomum Richiardi.†—Dr. C. Créty finds vitelline nuclei in variable number in the ova of this Trematode. He criticizes the various opinions held in regard to similar bodies in the ova of other animals, and believes that in *D. Richiardi* they are formed endogenously within and afterwards fuse with the protoplasm of the ovum which stains like chromatin. No other Helminth is known to have vitelline nuclei in its ovum, but in *D. megastomum* and *Hexacotyle Tynni* there are analogous diffuse granules.

Suckers of Distomum.‡—Dr. C. Créty describes the structure of the suckers in *Distomum megastomum* and *D. Richiardi*, and finds abundant ganglionic cells, from the presence of which he infers the tactile function of these organs.

Anatomy and Histology of Cestodes of Freshwater Fishes.§—Herr A. Kraemer finds that the Tæniæ of Fish as distinguished from those of warm-blooded Vertebrates present the following characters; the absence of a rostellum, in place of which there is often a fifth, small, sucker occupying the front end of the scolex; the presence of this apical sucker is certainly a primitive character, peculiar to the lower form of Tæniæ. The strobila are relatively short, their joints are closely connected with one another; no terminal joints are cast off; at the tip of the last, and, as a rule, conical joint of the chain there opens the terminal vesicle of the excretory system, into which all the longitudinal vessels open. The excretory apparatus opens by means of fine canaliculi in the neck and the youngest joints; these branch off from a capil-

* Arch. f. Naturg., lvii. (1891) pp. 245-76 (1 pl.).

† Atti R. Accad. Lincei (Rend.), ser. v. vol. i. (1892) pp. 92-7.

‡ Tom. cit., pp. 21-6 (2 figs.).

§ Zeitschr. f. Wiss. Zool., liii. (1892) pp. 647-722 (2 pls.).

lary vascular plexus. The vagina opens near and in front of the male generative orifice, whereas in other *Tæniæ* it is either below or behind the male orifice. The *Tæniæ* of fish also appear to be characterized by the vagina forming a number of loops, which function as a receptaculum seminis, before it opens into the ootyp. The yolk-glands have a position and form in which they differ from those of warm-blooded *Tæniæ* and approach, on the one hand, *Tetrabothrium*, *Anthobothrium*, and some *Bothriocephalidæ*, and on the other numerous *Trematoda*.

Gymnorhynchus reptans.*—M. R. Moniez has succeeded in finding the adult stage, not before known, of this *Tetrarhynchid*. He obtained it from the intestine of *Oxyrhina glauca*, in which Shark it was found by Baron de Guerne. It is about 30 cm. long, and so disposes of Oerley's statement that the *Cestodes* of Cartilaginous fishes are always of small size. The ripe joints are almost square, being 4.5 to 5 cm. wide and 5 to 6 cm. long. The vesicle of the larva is not found in the adult.

Bothriocephalus latus in Sweden.†—Dr. E. Lönnberg has made an investigation into the presence of this tapeworm in Sweden. It is rather rare and sporadic in the southern provinces; in the town of Söderhamn, however, fifty-five cases have been observed by one physician in fifteen years, and elsewhere it is supposed that 10 per cent. of the population suffer from it. Its irregular distribution appears to depend on the different habits of the people in various parts and on the number of worms which they take.

Parasites of *Trutta salar*.‡—Prof. F. Zschokke gives an account of the parasite-fauna of this trout, the number of which reaches the extraordinary total of thirty-three; there are seven *Nematodes*, four *Acanthocephali*, seven *Trematodes*, and fifteen *Cestodes*. The intestinal tract, its walls, the peritoneum, liver, spleen, kidneys, generative organs, are all infected.

Entozoa of Marine Fishes of New England.§—Mr. E. Linton presents a second report on this subject, in which he deals in a very detailed manner with forty-two species of *Cestode* parasites. So far as the author's investigations go it appears that very few of the *Cestode* Entozoa of fish "pass their adult stage in different specific hosts;" with encysted forms, however, the range of hosts appears to be greater.

The new genera formed by Mr. Linton are *Rhinobothrium* for *R. flexile*, *R. cancellatum*, and *R. longicolle* spp. nn., found respectively in *Trygon centrura*, *Rhinoptera quadriloba*, and *Myliobatis fremenvillei*; *Discocephalum* for *D. pileatum* sp. n. from *Carcharias obscurus*; *Anthocephalum* for *A. gracile* sp. n. from *Trygon centrura*; *Lecanicephalum* for *L. peltatum* sp. n. from the last-mentioned host; *Tylocephalum* for *T. pingue* sp. n. from *Rhinoptera quadriloba*; *Platybothrium* for *P. cervinum* sp. n. from *Carcharias obscurus*; *Otobothrium* for *O. crenicolle* sp. n. from *Sphyrna zygaena*; and *Paratænia* for *P. medusia* from *Trygon centrura*; this last worm is exceedingly small and the head exhibits great variability.

* Comptes Rendus, cxliii. (1891) pp. 870-1.

† Centralbl. f. Bakteriöl. u. Parasitenk., xi. (1892) pp. 189-92.

‡ Op. cit., x. (1891 and 2) pp. 694-9, 738-45, 792-801, 829-38.

§ Report U.S. Commission Fish and Fisheries, 1887 (1891) pp. 719-896 (15 pls.).

δ. *Incertæ Sedis.*

Moss-haunting Rotifers.*—Mr. P. G. Thompson gives a general account of the rotifers found in moss, and describes two new species which he calls *Macrotrachela multispinosa* and *M. papillosa*. The former is the second species of the genus known to bear spines, and the second is covered with conspicuous blunt papillæ about its foot. Both are British.

Floscularia Gossii.†—Mr. J. Hood describes a new *Floscularia* found on *Chara foetida* taken from the Stormont Loch, Blairgowrie, of which he was so fortunate as to find the male as well as the female. The former is a symmetrically formed maggot with a wreath of cilia to propel it through the water, in which it moves very swiftly. The female has the coronal head in the form of a bell-shaped cup, and differs from *F. calva* in having three instead of two lobes. The tube which it forms is rougher and stronger than in any already known species of the group.

Floscularia quadrilobata.‡—Mr. J. Hood describes a new species of *Floscularia* which is remarkable as having four lobes; each of these bears a fan-shaped tuft of very long setæ. Encased in a clear crystalline tube it is, we are told, an object of great beauty. The whole length is one-seventieth of an inch, and the species was found in a pond a few miles north of Dundee, attached to *Ranunculus* and *Nitella*.

Echinodermata.

Oogenesis and Spermatogenesis in Echinoderms.§—M. L. Cuénot draws attention to the lacunæ in our knowledge of the evolution of the sexual products of Echinoderms, and asks what is the exact and precise part played by the sexual cells of the genital cords in the new formation of genital cells after an evacuation of them. Is there a migration in mass of the cells of the cords, or do the new products arise from young ova or from spermatogonia?

Echinoderms of Cape Horn.||—In the only part of this memoir as yet published, Prof. C. Perrier deals with the Asteroidea and discusses a number of interesting points.

New Genera.—The author thinks it advisable to distinguish under the name of *Diplasterias* such species of the genus *Asterias* as have two rows of ambulacral spines or arc, to use Bell's nomenclature, diplacanthid. *Poraniopsis*, *Cribraster*, *Lebrunaster*, and *Asterodon* are new genera that connect hitherto isolated genera.

Attachment of Young.—Special attention is directed to the attachment of the young to the parent, especially as seen in *Asterias spirabilis* Bell; in this species the disc of the mother is slightly elevated, and the anus approximated at the base; the young, of which as many as twenty

* Science-Gossip, 1892, pp. 56-61 (8 figs.).

† Internat. Journ. Micr. and Nat. Sci., ii. (1892) pp. 73-8 (2 pls.).

‡ Internat. Journ. Microscopy, ii. (1892) pp. 26-8 (2 pls.).

§ Zool. Anzeig., xv. (1892) pp. 121-5.

|| 'Mission Scientifique du Cap Horn, vi. Zoologie, Echinodermes,' Paris, 4to, 1891, 198 pp. and 13 pls.

could be counted, were collected together at the centre of the lower surface of the disc and masked altogether the oral orifice. It is evident from their position that they can take no food during the period of gestation. M. Perrier has not been able to assure himself of the existence of any special organ of adhesion to the mother, but it is clear that all the individuals are fixed to a membrane, which is given off from the body of the mother, by a soft peduncle. This membrane is, probably though not certainly, part of the membrane of the stomach which is protruded for the support of the young. The author suggests that the soft peduncle is the homologue of the stalk of Crinoids.

Morphology of Skeleton of Young Asterias.—On this subject the author does not treat at the length which characterizes many contributions on it, but he promises to return to it, and he asks a question which may require some answering, and that is why the Crinoidea want the so-called terminal plate which appears at such an early stage in Starfishes and Brittlestars.

Prof. Perrier next discusses the characters of the attached young of *Asterias spirabilis* Bell, and points out that, as in *A. varia* Phil., they do not acquire a mouth for some time. The stomachal sac and the brachial diverticula are filled with yolk-spheres. Special attention is given to the "sacciform organ," the "plastidogenous organ," and the sand-canal; the development of the madreporic plate; and the constitution of the subambulacral cavities and of the nervous system, for which we must refer the student to the memoir itself.

In dealing with the budding of arms in *Labidiaster radiosus*, Prof. Perrier points out that in Starfishes we may see the following phenomena; (1) In all species mutilated parts are reformed; (2) in a number one-half of the body is almost always being regenerated; (3) an arm, being separated by accident, forms, in some species, a new Starfish; (4) in some species, especially of *Linckia*, the arms become detached spontaneously, and each forms a new Starfish; (5) the number of arms is not constant in the same species. All these characters can be paralleled by what may be seen among the Cœlenterata, but it has always been held that all the rays of a Starfish were formed simultaneously during larval life, and this has been taken as an important distinction. Now, however, we know that in *Labidiaster* new rays become budded from the disc among the old ones. In the author's opinion this completely justifies the assimilation of the ramified body of a Starfish to the ramified body of a Hydroid or a Coral.

In the systematic portion of his memoir Prof. Perrier recognizes five chief divisions—the Forcipulatæ, Spinulosæ, Valvulatæ, Paxillosæ, and Velatæ, the last being a new group for the Pterasteridæ, which he separates from the Paxillosæ. *Asterias Hyadesi* Perrier is regarded as a synonym of *A. spirabilis* Bell; its habit of guarding its young is a characteristic which is very common among the animals of the cold and temperate regions of the southern hemisphere. Among the many interesting forms which are discussed at length *Cycethra simplex* Bell may be specially mentioned; this species, originally founded on a single specimen collected by H.M.S. 'Alert,' is regarded by Prof. Perrier as one capable of considerable variation; in an appendix, written after the publication of Mr. Sladen's report on the 'Challenger' starfishes, in

which three new species, all from the neighbourhood of Cape Horn, are described, it is pointed out that if species are to be thus refined, nine species may, altogether, be recognized. Having thus reduced the matter to an absurdity Prof. Perrier concludes that there is but one species, and that capable of some variation. *Pentagonaster Belli* Studer is, perhaps, also a synonym of *C. simplex*.

In the course of the memoir there are numerous important criticisms of the recent work of Mr. Sladen and M. Cuénot.

Calamocrinus Diomedæ.*—Prof. A. Agassiz has published a detailed account of this remarkable stalked Crinoid, the preliminary notice of which we reported more than a year since.† The author is inclined to think that there is evidence of a closer structural affinity between the Brachiata Crinoids and the Blastoids than the late P. H. Carpenter was willing to admit. After treating in order of the calyx, arms, arn-joints, pinnules, side and covering plates, interradianal plates, ventral surface, orals, stem, and top-stem joint, he discusses the stems of some fossil Crinoids and the structure of the stem. In conclusion Mr. Agassiz has some notes on the apical system and the homologies of Echinoderms, in which he criticizes much of the work of the last twenty years. He urges the fact that the different classes of Echinoderms have developed independently from the earliest fossiliferous times causes the greatest difficulties we have to encounter in tracing back the earliest history of the Echinoderms; as has been often shown, we find representatives of the different orders very highly specialized in the oldest of the fossiliferous beds, and they scarcely bring us nearer to the primordial echinodermal type than we are to-day.

Comatulidæ of Indian Archipelago.‡—Dr. C. Hartlaub has published a report on the Comatulidæ collected by the late Dr. Brock, chiefly at Amboina. There were in all twenty-one species, nine of which are now described for the first time. The classification of species introduced by Carpenter is followed.

Cœlenterata.

Notes on Anthozoa.§—Dr. G. v. Koch describes what seem to be abnormal colonies of *Bebryce mollis* which exhibit true stolons, like those of Cornularidæ, with simple polypes and also tufts. In connection with the formation of the skeleton in Gorgonidæ this case is important, for the stolons secrete basally (from the ectoderm) a horny lamella, on which among several polype-cavities small axes are built up. These elongate with the further growth of the polypes, and branch like the axes of normal stocks.

The author also describes "aggregated colonies" of *Balanophyllia verrucaria* which are hardly distinguishable physiologically from those which arise by budding.

* Mem. Mus. Comp. Zool., xvii. (1892) 95 pp. (32 pls.).

† See this Journal, 1891, p. 202.

‡ Nova Acta k. Leop.-Carol. Akad. Halle, lviii. (1891) pp. 1-120 (5 pls.).

§ Morphol. Jahrb., xviii. (1892) pp. 372-83 (7 figs.).

Porifera.

Gemmules of Ephydatia.*—Herr W. Zykoff has investigated the development of the gemmules of *Ephydatia fluviatilis*. The first hint of their development is the appearance of refractive (yolk) granules in the amoeboid cells; these cells (Trophophores of Marshall) combine in company with ordinary parenchymatous cells; neither ciliated chambers nor canals have any part in the making of the gemmules; the trophophores unite in a central clump around which the parenchymatous cells are ranged concentrically; the number of granules in the cells of the central mass increases, and ordinary parenchymatous cells which have been included disappear; the peripheral parenchymatous cells become club-shaped and radially grouped, as Goette has described; they form only one layer; the lower, disc-like ends of the club-shaped cells secrete a chitinous cuticle—the first sheath of the future shell of the gemmule; there is no “enveloppe primitive,” such as Wierzejski has described, around the central mass; the amphidiscs are not formed, as Goette described, in the club-shaped cells, but outside of them, as Wierzejski stated; they become grouped in concentric zones round the club-shaped cells, but penetrate gradually into the cellular layer and are distributed within it; the cells pressed out by the amphidiscs form externally a second chitinous cuticle; they atrophy as the gemmule is completed. It is on physiological grounds unlikely that the same cells could form both chitin and siliceous amphidiscs.

Rare European Spongillidæ.†—Dr. A. Wierzejski records his discovery in Galicia of the rare Spongillid *Carterius Stepanovii* Petr. (*Dossila Stepanovii* Dyb.) which has only been found three times in Europe, and of the North American *Heteromeyenia repens* Potts, for the first time found in Europe.

Homodermidæ.‡—Dr. R. v. Lendenfeld replies to Bidder's criticism of his two families Homodermidæ and Leucopsidæ, maintaining that they are thoroughly justifiable. The family Homodermidæ depends not solely on *Homoderma*, though Lendenfeld adheres to his description of that genus, but also on other forms, one of which the author has recently described as *Homandra falcata*.

Sponges of the Adriatic.§—Dr. R. v. Lendenfeld has commenced a monographic account of the Sponges of the Adriatic, as it is now nearly thirty years since the late Oscar Schmidt published his well-known work. He gives full descriptive accounts of thirty-two species, all belonging to the Calcispongæ.

Study of Clionidæ.||—M. E. Topsent gives a monographic review of the genera *Cliona*, *Thoosa*, and *Alectona*, the later of which are distinguished from the first by having their principal microsceres amphasters and not spirasters. He places them among the Clavulidæ, of which they are the perforating forms. The perforating genus *Saurus* of Gray is regarded as a true Tetractinellid, and not as a Clionid.

* Zool. Anzeig., xv. (1892) pp. 95-6.

† Biol. Centralbl., xii. (1892) pp. 142-5. ‡ Zool. Anzeig., xv. (1892) p. 109.

§ Zeitschr. f. Wiss. Zool., lii. (1891) pp. 185-321 (8 pls.).

|| Arch. Zool. Expér. et Gén., ix. (1891) pp. 555-92 (1 pl.).

Protozoa.

Vitality of Germs of Microscopic Organisms.*—M. A. Certes, who has for fourteen years been experimenting on the vitality of germs, communicates the results of his observations. All sedimentary deposits, whatever their origin and however long their period of desiccation, give when cultivated various microbes belonging either to raro or to well-known species. Cultivations of marine sediments taken from the surface (débris, Algæ, &c.), or from great depths, do not produce either ciliated Infusoria or higher animals. Small organisms, to be discussed on a future occasion, were found in addition to microbes, Rhizopods, and Flagellata. Cultivations of sediments of fresh or brackish water, and, more certainly, of hay, leaves, and dry grasses, always give Flagellata and Ciliata and sometimes Rotifers and Annelids. The same is true of salt lakes.

It follows, therefore, that matters are so arranged that the repopulation of lakes and marshes is assured even after the most prolonged periods of drought to which they are subjected. But this law does not apply to marine species which are never subjected to prolonged desiccation.

Foraminifera of Southport.†—Mr. G. W. Chaster has a report on the Foraminifera of the Southport Society of Natural Science District; a few of the forms met with in shore gatherings have as yet only been recorded from considerable depths; among them are *Nodosaria calomorpha* Reuss, and *Haplophragmium anceps* Brady. As a basis for the present report the author has taken Mr. H. B. Brady's 'Synopsis of Recent British Foraminifera' published in our Transactions for 1890. The new species are *Rheophax scotti*, *Textularia fusiformis*, *Clavulina obscura*, *Lagena milleti*, *L. falcata*, *L. depressa*, *L. protea*, *Lingulina herdmanni*, *Discorbina minutissima*, and *Pulvinulina nitidula*.

Myxosporidium bryozoides.‡—Prof. A. Korotneff describes a *Myxosporidium* which he found living on the freshwater Bryozoon *Alcyonella fungosa*; it is the only Amœboid form which appears to belong to the Myxosporidia. The size of the masses formed by it varies considerably from 0.02 mm. to 0.2. The form varies with the size, the smaller being spherical, the larger oval or lobate. The protoplasmic bodies are naked and amœboid, the endosarc is strongly granular and the ectosarc hyaline. The pseudopodia formed by the latter are very fine, and are ordinarily developed at one part of the body only. The processes often form small, branched tufts, and they appear, at times, to serve as means by which the Myxosporidia are attached to the funiculus of the Bryozoon. In the endosarc, which appears to take no part in forming the pseudopodia, there are a number of small cell-nuclei, in which nucleoli can be distinguished, and special spores, the structure of which could not be satisfactorily made out owing to the resistance of their shells. These spores appear to have an endogenous origin.

New Marine Rhizopod.§—Under the name of *Pontomyxa flava* M. E. Topsent describes a new reticulose Amœboid which he found

* Comptes Rendus, cxiv. (1892) pp. 425-8.

† Southport Soc. Nat. Sci., i. (1892) pp. 54-72 (1 pl.).

‡ Zeitschr. f. Wiss. Zool., liii. (1892) pp. 591-6 (1 pl.).

§ Comptes Rendus, cxiv. (1892) pp. 774-5.

forming yellowish spots on *Microcosmus Sabatieri* at Banyuls. It is characterized by its colour, large size (it may extend over six centimetres), the complete absence of vacuoles, and the enormous quantity of its nuclei. In other points its organization is exceedingly simple. It has not been observed to form cysts or spores.

A Marine Cryptomonas.*—M. P. A. Dangeard signalizes the existence of a marine *Cryptomonas*, a few examples of which he observed at Luc-sur-Mer. In colour it approaches *C. erosa*, in form and size *C. ovata*. The author recognizes the incompleteness of his short description, and names the species *C. marina*.

Pteromonas alata Cohn.†—M. Golenkin has found this unicellular organism in a ditch near Moscow, and identifies it with *Cryptoglena angulosa* Cart. and *Phacotus angulosus* Stein. It is characterized by the possession of a shell composed of two equal halves, which leaves an incombustible, probably siliceous, skeleton, after heating with nitric acid. It has a rod-shaped eye-spot. Non-sexual multiplication takes place after the manner of the Chlamydomonadeæ; sexual reproduction by the copulation of two similar microgonids, which are formed in numbers varying from 8 to 32 in a mother-cell. The germination of the zygotes was not observed, nor any palmella-condition.

Classification of Coccidia and Gregarinida.‡—Sig. P. Mingazzini reviews the various classifications proposed by Kölliker, Stein, Gabriel, Bütschli, and others, and argues in favour of his own:—

Body of one segment.	{	Cocciidea ..	Spherical or oval, non-mobile, not conjugating, living within cells or tissues.
		Monocystidea ..	Variable in form, mobile, generally free; conjugation, when it occurs, almost always by "opposition."
Body of two or more segments.	{	Polycystidea ..	Two segments, of which the anterior may bear an accessory piece; conjugation, when it occurs, almost always by "opposition."
		Didymophyidea.	Three segments; the individual results from the conjugation of two by "opposition."

New Coccidia parasitic in Fishes.§—M. P. Thélohan has a few observations on Coccidia found in the Sardine, Tench, and *Caranx trachurus*, and directs attention to the presence in the tissues of various Fishes of small ovoid bodies with a thick membranous envelope, and a nucleus; he is of opinion that they are parasitic organisms, but does not know with what known parasite they have any relation.

Hæmatozoon of Malaria.||—Dr. P. Hehir, of the Nizam's Medical School at Hyderabad, has published an account of his microscopical observations on the Hæmatozoon of Malaria. He looks upon the hæmatozoon as a polymorphic organism.

* Le Botaniste (Dangeard) iii. I. (1892) p. 32 (1 fig.).

† Bull. Soc. Imp. Nat. Moscou, 1891, 16 pp. (1 pl.). See Bot. Ztg., 1. (1892) p. 66.

‡ Atti R. Accad. Lincei (Rend.), ser. v. vol. i. (1892) pp. 68-75.

§ Comptes Rendus, cxiv. (1892) pp. 136-8.

|| Separate copy, sent by author, no date, no place of publication, 4to, 27 and ii. pp. (9 pls.).



BOTANY.

A. GENERAL, including the Anatomy and Physiology
of the Phanerogamia.

a. Anatomy.

(1) Cell-structure and Protoplasm.

Cells and Energids.*—Prof. J. Sachs points out the confusion which has resulted from the various meanings in which the word "cell" has been used by different writers. The vital properties do not reside in the cell-nucleus alone, nor in the protoplasm alone which surrounds it, but in the two together; and to this compound structure he proposes to apply the term *energid*. An energid may be destitute of a cell-wall (primordial cell), or each energid may be inclosed in its own cell-wall (ordinary cells), or a number of energids may be inclosed in the same cell-wall (multinucleated cells). It is exclusively on the multiplication in the number of energids that all growth depends.

(2) Other Cell-contents (including Secretions).

Chemistry of Chlorophyll.†—Mr. E. Schunck describes the product resulting from the action of alkalis on chlorophyll, which he terms *alkachlorophyll*. It exhibits in solution a remarkable degree of permanence when exposed to the combined action of air and light, as compared to chlorophyll. It shows no signs of crystalline structure, is quite insoluble in boiling water, but easily soluble in alcohol, ether, chloroform, benzol, anilin, and carbon disulphide; it is insoluble in petroleum ether. Its solutions have a brilliant green colour with a pronounced bluish tinge and a marked red fluorescence. The ethereal solution shows no less than six absorption bands.

Formation of Starch.‡—From observations made on plants belonging to a large number of natural orders of Angiosperms, Herr J. C. Koningsberger comes to the following conclusions:—Starch may be formed either from pre-existing leucoplasts, or directly by the activity of the protoplasm. The former process, which is probably the general one, is more characteristic of Monocotyledons, the latter of Dicotyledons. In Dicotyledons there is, in consequence, a reduction of the chromatophore-system in comparison with the leucoplasts; the chromatoplasts may even entirely disappear. The first stage in the formation of a starch-grain is probably a deposition of amyloextrin. Both leucoplasts and (in higher plants) the protoplasm possess the power of polymerizing the carbohydrates with lower into carbohydrates with higher molecular weights, which constitute the definite form of the reserve food-materials.

Proteids of Maize.§—Mr. R. H. Chittenden and Mr. T. B. Osborne have carefully investigated the proteids of the seed of *Zea Mays*, and find

* Flora, lxxv. (1892) pp. 57-63.

† Proc. Roy. Soc. l. (1892) pp. 302-17 (1 fig.). Cf. this Journal, 1889, p. 539.

‡ 'Bijdr. tot d. Kenn. d. Zetmeelvorming b. d. Angiospermen,' Utrecht, 1891 (1 pl.). See Bot. Centralbl., xlix (1892) p. 47.

§ Amer. Chem. Journ., xlii. (1891) pp. 453-68, 529-52; xiv. (1892) pp. 20-44. Cf. this Journal, *ante*, p. 58.

that they comprise several distinct substances of characteristic reactions and composition. The most noteworthy of these is *zein*, or maize-fibrin, characterized by its high content of carbon, by its resistance to the action of dilute alkalies, and by the ease with which it is converted into an insoluble modification on being warmed with water or with very weak alcohol. Zein is soluble in warm dilute alcohol, insoluble in water.

Tannins in the Living Cell.*—Herr R. Büttner gives a list of 24 reagents for the presence of tannins in the living cell, and adds the following remarks. Substances which give the reactions of tannin are found in varying proportions, often considerable, in larger or smaller vacuoles in the cell-sap. In such vacuoles no membrane could be detected. The chlorophyll-bodies, pyrenoids, nuclei, or nucleoles, never show a tannin-reaction in the living cell; and this reaction is not due to solid bodies previously formed in the living cell. Septa sometimes exhibit the reactions of tannin. Some species of *Cruciferae* examined contained no tannin.

Alkaloids of the Solanaceæ.†—Herr W. Schütte summarizes his conclusions thus:—(1) The younger roots of wild belladonna contain only hyoscyamine, while the older roots contain atropine as well as hyoscyamine, but only in small proportion. (2) The ripe berries of *Atropa belladonna nigra* contain atropine and hyoscyamine; those of the wild plant contain atropine only, and the ripe fruit of *A. belladonna lutea* contains another base perhaps identical with atropamine. (3) The leaves of the yellow and black-fruited wild *A. belladonna* contain hyoscyamine and a small quantity of atropine. (4) Fresh and old seeds of *Datura stramonium* contain chiefly hyoscyamine. (5) *Solanum tuberosum* contains, besides betaine, an alkaloid which causes mydriasis. (6) The mydriatic alkaloid contained in *Lycium barbarum* and *Solanum nigrum* exists only in small quantities, and appears to be identical with the base contained in *S. tuberosum*. (7) The leaves of *Nicotiana Tabacum* also contain traces of mydriatic alkaloids. (8) In the seeds, leaves, and root of *Anisodus luridus*, gathered in autumn, hyoscyamine only has a pre-existence.

Hyoscyamine in the Lettuce.‡—Mr. T. S. Dymond describes the method by which he obtained a crystalline alkaloid from the lettuce, which on examination was found to be hyoscyamine. It is probably to this alkaloid that the sedative and anodyne action of the preparations of the plant is due; and it is a fact of special importance, as hitherto no alkaloid belonging to the mydriatic group has been found in a plant not belonging to the Natural Order Solanaceæ.

(3) Structure of Tissues.

Laticiferous System of Papaveraceæ.§—M. J. Léger states that in some species of Papaveraceæ—*Eschscholtzia californica*, *E. tenuifolia*, and

* 'Ueb. Gerbsäure React. in d. lebenden Pflanzenzelle,' Erlangen, 1890, 63 pp. See Bot. Centralbl., 1891, Beih., p. 513.

† Arch. Pharm., pp. 492-531. See Journ. Chem. Soc., 1892, Abstr., p. 231.

‡ Journ. Chem. Soc., 1892, pp. 90-4.

§ Bull. Soc. Linn. de Normandie, v. See Bonnier's Rev. Gén. de Bot. iv. (1892) p. 139.

Hypercium procumbens—which have true laticiferous vessels, the red latex, similar to that of *Glaucium* and the *Fumariaceæ*, which they contain when young, is replaced subsequently by a yellow liquid; and he traces a transition between the laticiferous system of *Papaveraceæ* and that of *Fumariaceæ*.

Herr W. Zopf,* on the other hand, regards the alleged laticiferous vessels of the *Fumariaceæ* as alkaloid-receptacles.

Formation of Secondary Medullary Rays.†—According to Herr E. Schmidt, the initial of a secondary medullary ray always differs more or less in form from the cells formed later. This initial cell is not the result of a sudden change in function of a cambium-cell, but of the intercalation of tracheids among the delicate younger cells lying towards the cortex, the newly formed medullary-ray-cell following the example of such a tracheid. After the cambium-cell has cut off a number of tracheids, the first medullary-ray-cell appears as the result of a horizontal division in the upper part of a cambium-cell; and the cell thus cut off assumes more and more a triangular or quadrangular form. In the formation of a medullary ray from a cambium-cell, its upper or lower end is cut off by a horizontal septum; and the end thus cut off is the initial of a medullary ray.

Cells of the Mesotheca of Hydrangea.‡—Sig. M. Geremicca describes the peculiar form of the cells of the mesotheca, the hypodermal layer in the anther, in *Hydrangea hortensis*. They are thickened by long narrow bands which run in a parallel direction on the lateral walls of the cells, and unite below, so as to form a kind of open cup. Instead of "fibrous cells" or "band-cells," as these cells have previously been called, the author proposes to term them the thickening cells of the mesotheca.

Stem of Asclepiadaceæ.§—Herr K. Treiber has undertaken a detailed examination of the anatomical structure of the stem of a large number of species of *Asclepiadaceæ*. Isolated procambial bundles were never found, but always a closed procambial ring, out of which are differentiated not only the primary bast-fibre groups and the primary internal and external phloem-groups and vessels, but also the parenchymatous tissue and the cambium. Besides the external and internal phloem (in relation to the xylem), some species have bundles of phloem in the pith; while occasionally there is a paraxylary phloem in the thin-walled xylem-parenchyme. The primary vessels are chiefly collected into four groups, corresponding to the insertions of the decussate leaves; a few lie scattered irregularly between these. The special characteristics of the climbing species are also described.

Anatomy of Nicotiana.||—Dr. J. B. de Toni and Sig. J. Paoletti describe in detail the anatomical structure of the various organs of *Nicotiana Tabacum*. Among the more important points is the observa-

* Ber. Deutsch. Bot. Gesell., ix. (1891) pp. 107-17.

† 'Beitr. z. Kenntn. d. secundären Markstrahlen,' Berlin, 1890, 32 pp. and 2 pls. See Bot. Centralbl., 1891, Beih., p. 514.

‡ Bull. Soc. Bot. Ital., i. (1892) pp. 37-9.

§ Bot. Centralbl., xlviii. (1891) pp. 209-18, 241-9, 273-81, 305-13 (2 pls.).

|| Ber. Deutsch. Bot. Gesell., ix. (1891) Gen.-Versamml.-Heft, pp. 42-51 (2 pls.).

tion that the vascular bundles of the stem are bicollateral. Besides the normally developed leptome there are formed in the pith several leptome-bundles which arise in the medullary parenchyme quite independently of the outer leptome.

(4) Structure of Organs.

Morphology of the Carpel.*—Sig. F. Pasquale proposes a new theory of the morphology of the carpel, founded on an extended observation of the course of the vascular bundles, chiefly in the Sterculiaceæ, Leguminosæ, and Crucifereæ. Instead of being, according to the prevalent view, a single modified leaf, the carpel is, according to him, the result of the concrescence of three, less often of two, leaves, which take part in the formation and in the nutrition of the ovules and of the seeds. He terms it, therefore, a *triphyllome*, of which one leaf is sterile, and has an inferior position, the other two are superior and fertile. Between the fertile and the sterile leaves there is an actual and intimate fusion, with perfect anastomosis of the ultimate ramifications of the vascular bundles, and even of the mesophyll and the epiderm. Each fertile leaf is composed of a membranous portion with a system of vascular bundles, the *placental hemiphyll*, and of an *ovular hemiphyll*, which is entirely transformed into the placental body and the ovules; by the placental body is understood the whole of the tissues which constitute the placenta, together with the funicles, the style, and the stigma. The sterile leaf, represented by the dorsal portion of the consolidated carpellary leaf, is frequently reduced to a single principal bundle with a few lateral bundles; sometimes it is altogether wanting. The fertile leaves unite with one another by their respective mid-ribs. Each fertile leaf is composed of a membranous hemiphyll, which takes part in the formation of the pericarp or of the septum, and of a hemiphyll folded in the cavity of the carpel, and transformed into a placental body. The ovules originate from the whole of the ovular hemiphyll, and not merely from the carpellary teeth or margins. In many monocarpellary pistils, such as those of Gramineæ, Compositæ, and Leguminosæ, two stigmas are present, owing to their origin from two fertile leaves. The false septum of Crucifereæ is an emergence of the ovular hemiphylls.

Fruit of the Bay.†—Sig. F. Neri describes the fruit of *Laurus nobilis*, which with Luerssen he is inclined to call drupaceous. The epicarp adhores closely to the soft mesocarp, and the endocarp clings to the seed. The single layer of epidermal cells forming the epicarp and the lenticels which replace some of the stomates; the hypodermal part of the mesocarp consisting of two or three layers of flattened cells with dense pigmented protoplasm, and the thicker internal portion with oil-cells; the thin endocarp, the seed, and the embryo, are all described.

Ovule and Seed of Trapa.‡—Dri. G. Gibelli and F. Ferrero have made a careful study of the structure of the ovary and ovule, the mode of impregnation, and the structure and development of the ovule, in *Trapa natans*, which bring them to the conclusion that it presents

* Bull. Soc. Bot. Ital., i. (1892) pp. 26-36.

† Atti Soc. Tosc. Sci. Nat., vii. (1891) pp. 309-14.

‡ Malpighia, v. (1891) pp. 156-218 (10 pls.).

important deviations in structure from both Dicotyledons and Monocotyledons.

The nucellus is at first naked, but is afterwards covered by two teguments. The suspensor is composed of two elongated cells, which subsequently divide by longitudinal walls. From the suspensor is formed a kind of cap which develops into an aril covering the embryo on the whole of the side which faces the raphc. Between the nucellus and the embryo is a layer of absorbing cells which appear to serve as organs for the transmission of albuminoid materials from the nucellus to the embryo.

The outer tegument of the seed is derived directly from the outer tegument of the ovule, and from the transformation of its parenchymatous and vascular elements. The mature embryo must be regarded as an amorphous mass, a true thallome, on which is developed a single bud; it is a degraded embryo with only a single cotyledon. This degradation of the embryo resembles that which occurs in parasitic and semi-parasitic plants, such as Orchideæ, *Orobanche*, *Cynomorium*, *Balanophora*, *Monotropa*, *Cuscutæ*, &c., and in some aquatic genera, c.g. *Zostera*, *Hydrocharis*, *Utricularia*, &c. In *Trapa*, as is always the case in Monocotyledons, the single cotyledon is not lateral, but terminal; but the plumule does not make its appearance in a lateral niche of the cotyledon as it develops, but in the slender portion from which the root is produced; and the protecting scale (regarded by some authors as a second small cotyledon) appears behind the germinal tubercle. Except in the absence of endosperm, the development of the embryo resembles that in typical Monocotyledons.

Comparative Anatomy of Leaves.*—According to M. C. de Candolle, intramedullary vascular bundles in the petiole and veins of the leaf are far more frequent among Dicotyledons than has hitherto been supposed. He has found them in members of 42 distinct families scattered through all the classes. He finds also that the Rosaceæ, with the exception of the tribe of Chrysobalanæ and a few species in other tribes, are characterized by an imperfect internal structure shown by the absence of vascular bundles on the upper surface of the leaf.

Leaves of Iridææ.†—Prof. R. Chodat describes the anatomical structure of the leaves of the following genera of Iridææ:—*Iris*, *Crocus*, *Gladiolus*, *Montbretia*, *Crococoma*, and *Sisyrinchium*, and finds distinguishing characters in the details which are useful for purposes of classification. These depend mainly on the structure and arrangement of the vascular bundles, and on the structure of the cortical parenchyme. The stereids are less lignified in proportion as they are in direct contact with the fibrovascular bundles.

Leaves of Eucalyptus.‡—Sig. G. Briosi describes in detail the anatomical structure of the leaves of *Eucalyptus globulus*, which are of three kinds,—the cotyledonary, the younger horizontal, and the later sickle-shaped vertical leaves; there is a gradual passage from the second to

* Arch. Sci. Phys. et Nat., xxvi. (1891) p. 501.

† Tom. cit., pp. 496–500.

‡ 'Ric. int. all' anatom. d. foglie d. *Eucalyptus globulus*,' Milano, 1891, 95 pp. and 20 pls. See Bot. Centralbl., xlix. (1892) p. 317.
1892.

the third of these. The cotyledons and horizontal leaves have stomates on the under side only, the vertical leaves on both sides. The glands, which are apparently a protection against excessive radiation, are distributed irregularly in the leaves, as also in the leaf-stalk, receptacle, and walls of the ovary; they are of lysigenous origin, resulting from the complete absorption of a secreting system. The vascular bundles of the stem are bicollateral; in the leaves the bundles are bicollateral in the stronger veins, passing into collateral in the finer veins. The author regards the horizontal as the original form of leaf, the vertical form being an adaptation protecting against the excessive transpiration resulting from too strong an exposure to light.

Leaves of Palms.*—From an examination of species belonging to 52 out of the 128 known genera of palms, Herr K. Zawada states that members of the same tribe, and even of the same genus, are distinguished by common anatomical characters. In the first rank are characters derived from the nature of the upper, and, when this is wanting, of the lower mid-rib, and from the presence or absence, and the nature of the hypoderm; and, subsidiary to these, the presence or absence and the nature of the stomates, and of the ring of sclerenchyme; the nature of the epiderm and mesophyll; the presence or absence of trichomes, raphides, and tannin-sacs; the presence of one or more phloems and of pitted vessels in the large vascular bundles; and the arrangement of the veins in the lamina.

β. Physiology.

(1) Reproduction and Embryology.

Phenomena of Impregnation.†—M. I. Guignard describes in detail the researches hitherto made by others in the morphological phenomena of impregnation, together with his own most recent observations, and compares the results with those obtained in the animal kingdom by Van Beneden, Fol, Hertwig, and others.

In the formation of pollen-grains he distinguishes between the primordial mother-cells and the definite mother-cells of the pollen, the former being an earlier condition of the latter. It is at the moment when the cells of the tapetal layer are differentiated that cell-division ceases in the primordial mother-cells, and they become definite mother-cells.

Before arriving at maturity the pollen-grain of Angiosperms divides into two cells of unequal size, the smaller of which is the generative, the larger the vegetative cell; they differ from one another in form, structure, and reactions. The generative cell becomes free in the pollen-grain at a more or less advanced period of development, and usually takes the form of a lens or crescent having the nucleus in its centre. The generative nucleus, together with the protoplasm which surrounds it, undergoes a bipartition which (in *Lilium Martagon*) takes place only in the pollen-tube. It is sometimes the generative, sometimes the vegetative nucleus, which first enters the tube. In its course through the

* 'Das anat. Verhalten d. Palmenblätter,' Karlsruhe, 1890, 40 pp. See Bot. Centralbl., 1891, Beih., p. 517.

† Ann. Sci. Nat. (Bot.), xiv. (1891) pp. 162-288 (10 pls.). Cf. this Journal, *ante*, p. 64.

style the generative is usually somewhat in the rear of the vegetative nucleus, and differs from it in not being distinctly nucleolated. The generative nucleus continues to increase in size, while the vegetative nucleus rather diminishes. The former now divides into two, and the two secondary generative nuclei are equivalent in structure and in function; each of them has the power of fecundating the oosphere; but the object of this bipartition is not evident; each is furnished with its pair of directing spheres. The vegetative nucleus has disappeared by the time the pollen-tube has come into contact with the nucellus. After fecundation has taken place, the second generative nucleus is frequently seen close to the active male nucleus inclosed within the oosphere, but without uniting with the female nucleus.

The typical example of *Lilium Martagon* is closely compared by the author with the phenomena presented by other plants, e.g. *Fritillaria imperialis*, *Muscari comosum*, *Agraphis cernua*, *Alstrœmeria psittacina*, &c.

As regards the actual process of fecundation, no change is perceptible in the female nucleus until the male nucleus has itself come to rest; the latter has by this time increased in size, and its chromatic elements have become distinct, forming a network or framework. Its final size is, however, somewhat less than that of the female nucleus, though the quantity of chromatic substance appears to be the same in both. The rapidity of the union of the two nuclei varies greatly in different plants. Since the chromatic elements of the two nuclei do not unite, the process of fecundation must be regarded simply as a mixing of the soluble substances, the nuclear fluid and the product of resorption of the nucleoles.

The bearing of the facts above described on the various theories of impregnation and heredity is discussed at length.

Commenting on this paper, Herr E. Zacharias * maintains that, at the moment when the male nucleus enters the female nucleus, the two differ materially from one another in their morphological structure and in their chemical composition. It is possible that the amount of chromatin in the two may be the same before their union; but, owing to the difference in their size, the percentage composition differs considerably.

Abnormal Embryos of Nuphar.†—Herr F. Hegelmaier describes several abnormal embryos of *Nuphar luteum* in which the two cotyledons are more or less completely united into a sheath, split only on one side; but the two halves (corresponding to the two cotyledons) have developed very unequally, one of them being usually several times as long as the other.

Parasitic Castration by Ustilago antherarum.—According to M. P. Vuillemin,‡ the abortion of the ovaries of *Lychnis dioica* resulting from the attacks of this parasitic fungus is not complete, some of the ovules frequently escaping injury, and being fertile. He also states that the production of fertile stamens in the female flowers, said to result from the attack of the fungus, is entirely illusory. It does, no doubt, cause hypertrophy of the rudiments of stamens which always

* Bot. Ztg., l. (1892) pp. 246-8.

† J. Heft. Ver. vaterl. Naturk. Württemberg, 1890, pp. 88-97 (1 pl.). See Bot. Centralbl., xlix. (1892) p. 216.

‡ Comptes Rendus, cxiii. (1891) pp. 662-5. Cf. this Journal, 1890, p. 744.

exist in the female flowers; but not with the result of producing fertile anthers, but rather of organs in which the fungus carries out its full development, and discharges its spores in precisely the same way as the anther does its pollen-grains.

M. A. Mangin* brings forward some new facts concerning parasitic castration, confirming the observations of M. Vuillemin on *Lychnis dioica* when attacked by *Ustilago antherarum*:—(1) The possibility of local infection (verified by M. Vuillemin for *Lychnis dioica*) must be admitted also for *Euphorbia Cyparissias* and *E. verrucosa*, attacked by *Uromyces Pisi* and *U. scutellatus*. (2) The parasite only increases in size the rudiments of organs which already exist. (3) The author states that, as far as he is aware, ovaries have not been observed in the male ustilaginated flowers of *Lychnis vespertina* and *Muscari comosum*, thus adding another proof to the fact that the parasite cannot bring into existence organs which are completely wanting.

Function of Flowers in attracting Insects.† — Prof. T. Caruel doubts whether too much has not been taken for granted in the prevalent theory of the part played by the bright colour and sweet scent of flowers in attracting insects for the purpose of pollination; seeing that, as far as we know, the visual and olfactory organs and perceptions of many animals are very different from our own. In particular he calls attention to the obviously different effect of odours on many animals from that which they produce on us; to the eyes formed of facets and to the ocelli of insects; and to their sensitiveness to the ultra-violet rays of the solar spectrum.

Pollination of Autumn-flowering Plants.‡ — Dr. P. Knuth enumerates the pollinating insects to a large number of species of flowering plants natives of Northern Germany. As a general rule the number of insects visiting a species is considerably less than that described by H. Müller; this he attributes partly to the smaller number of insects in North Germany, but much more to the late period of the year at which the observations were made. In almost all cases insects with a wide distribution visit the same flowers in Northern and in Central Germany.

Pollination of Aristolochia.§ — Herr W. Burck recurs to the question of the self- or cross-pollination of this genus, the observations being made on *A. barbata*, *elegans*, and *ornithocephala*. He asserts that the flowers are not dichogamous, and confirms Van Tieghem's statement that the style and stigma are abortive, and that the so-called stigmatic surface consists of the connectives which have coalesced by their sides into a cup, are provided on their margins with papillæ, and have assumed the functions of a stigma. He states further that when flies enter the chamber formed by the lower part of the perianth, and become dusted with pollen, in their attempts to escape from the chamber they come again into contact with the woolly or glutinous hairs which clothe the walls of the chamber, and thus lose, before they pass to another flower, almost every grain of pollen. In *A. barbata* at least 600, and in

* Comptes Rendus, exiii. (1891) pp. 784-6.

† Bull. Soc. Bot. Ital., i. (1892) pp. 108-11.

‡ Bot. Centralbl., xlix. (1892) pp. 232-6, 263 7, 299-303, 360-7.

§ Bot. Ztg., l. (1892) pp. 121-9, 137-44 (1 pl.). Cf. this Journal, 1891, p. 216.

A. ornithocephala about 6000, pollen-grains are required for the complete fertilization of the ovary. Out of a very large number of observations made on flies captured in the chamber of *A. barbata* and *elegans*, only a very few showed the presence of even a small number of pollen-grains adhering to them. On the other hand all three species are abundantly fertile when pollinated with their own pollen.

From these observations Herr Burek concludes that the various species of *Aristolochia* are self-pollinated without any assistance from insects.

(2) Nutrition and Growth (including Germination, and Movements of Fluids).

Right-angled Succession of Cell-walls.*—Prof. J. Sachs recurs to his theory on the relation between growth and cell-division, viz. that in the growth of vegetable tissues the direction of the successive division-walls is at right angles to one another, whether periclinal, anticlinal, or transverse. The walls may themselves be curved, but at the point of intersection the angle is a right one. Prof. Sachs suggests that this law is as applicable to the animal as it is to the vegetable kingdom.

Dissemination of the Seeds of *Geranium bohemicum*.†—Dr. Lundström points out that the mode of bursting of the fruit in *Geranium bohemicum* differs from that in *G. sylvaticum* and other species. Instead of the mericarps separating from below and remaining for a time attached to the upper part of the column, they separate from above and remain buried in the calyx. Their dissemination cannot therefore be effected, as in other species of *Geranium* and *Erodium*, by the elasticity of the portion which remains attached to the central column. This upper part of each carpel, which remains attached to the seed, is, in *G. bohemicum*, spirally twisted, and its dissemination appears to be effected by its becoming attached to the fur or wool of creeping animals, or to the feathers of birds.

Germination of *Bupleurum aureum*.‡—M. P. Van Tieghem describes a peculiar mode of germination in *Bupleurum aureum* from Siberia, which has been observed in some other Umbelliferae, and in a few other plants. The two cotyledons have their petioles conerescent by their edges so as to form a tube. This cotyledonary tube is negatively geotropic in its upper portion, causing it to ascend vertically, while its lower part is positively geotropic, and strikes into the soil. It follows from this that geotropic characters cannot be used to determine the morphological value of an organ.

Autumn and Spring Flowering Plants.§—Herr A. F. Foerste advocates the view that the normal time for the flowering of plants is the late spring and early summer. In the struggle for existence two opposite tendencies have set in:—The one is to obtain advantage over surrounding plants by increasing in size, and thus securing more air, light, and room

* Flora, lxxv. (1892) pp. 63-7.

† Bot. Sekt. Naturv. Studentsällsk. Upsala, Feb. 28, 1890. See Bot. Centralbl., xlix. (1892) pp. 202 and 236 (9 figs.).

‡ Bull. Soc. Bot. France, xxxviii. (1891) pp. 402-3.

§ Bot. Gazette, xvii. (1892) pp. 1-8 (2 pls.).

for the development of their flowers; this tends to result in the flowers being produced in late summer and early autumn. The other is to gain advantage over other plants by the earlier opening of their flowers, by blossoming before the light and air are interfered with by the development of the foliage. This is effected by the reduction of their internodes, and results in the flowers opening in the early spring. Many flowers which ordinarily open in the autumn will not mature till the following spring when the conditions are unfavourable in the autumn.

Period of Formation of the Flower-buds in the Vine.*—According to Sig. U. Martelli there are two important periods in the development of the inflorescence of the vine. The first is in the summer (about August) the period of the first formation of the axial parts of the inflorescence; the second the early spring (after February) when the differentiation of the principal axis into secondary axes and flower-buds is effected. Winter is a period of rest, when there is no apparent increase in the buds. Examination in autumn of the degree of development of the third and fourth buds from the apex of the branch will indicate the prospects of the crop of grapes for the ensuing summer.

Sachs has shown that, of the various rays of the solar spectrum the yellow rays and those nearest them take the greatest share in the decomposition of carbon dioxide and the process of assimilation, the blue in the movements of stimulation and irritation, the ultra-violet in the production of the flowers and reproductive organs. But, in addition to this, the production of flowers and fruit is greatly aided by other agents, especially the mineral constituents of the soil, the relative value of which varies with different plants. For the vine salts of potash are of great importance.

Growth of Seedlings and Cuttings.†—Herr F. Hildebrand gives the results of several series of experiments, directed mainly in the following directions.

(1) In several woody myrmecophilous plants (*Cecropia peltata*, *Acacia cornigera*), the yellow excretion from the tips of the pinnate leaves which serves to attract ants, and the hollow thorns which furnish them with a habitation, both make their appearance only when the seedling has attained a considerable size. In *A. melanoxylon*, cutting down the stem of a mature tree which was producing only phyllodes caused a small degree of reversion to the early condition in which the leaves have a pinnate lamina. This was more strongly displayed in *Eucalyptus globulus*.

(2) The different sections of *Anemone* exhibit very different modes of germination. In species belonging to the section *Eu-anemone* (*blanda*, *memorosa*, *narcissiflora*, *fulgens*), the cotyledons and plumule remain buried in the soil, a single foliage-leaf appearing in the first stage of germination; or the cotyledons also emerge and act as organs of assimilation, while the plumule remains buried. In the section *Hepatica* (*Hepatica*, *angulosa*), both cotyledons and plumule emerge above the surface, but the latter is still enveloped in scales. In the section *Pulsatilla* again (*Pulsatilla*, *pratensis*, *vulgaris*), not only does the

* Bull. Soc. Bot. Ital., i. (1892) pp. 52-9.

† Bot. Ztg., i. (1892) pp. 1-11, 17-24, 33-42 (1 pl.).

plumule completely emerge, but it at once proceeds to develop five-toothed, afterwards three-lobed leaves. In all species of *Anemone* the seeds must be sown as soon as they are ripe, and not delayed till the following spring. *Melittis Melissophyllum* and *Dentaria pinnata* and *digitata* diverge from the usual conditions of the orders to which they belong, in the cotyledons remaining buried beneath the surface.

(3) In various plants the author observed the peculiarity of the apex of the seedling burying itself in the earth.

(4) A fourth series of experiments related to the effect of external influences on the form of the leaves in seedlings, but these did not lead to any decisive result.

Parasitism and Multiplication of *Cynomorium*.*—Pursuing his observations on the growth and mode of parasitism of *Cynomorium coccineum*, Sig. U. Martelli observes that the cone-like bodies which penetrate into the tissue of the host are not haustoria, but have all the characters of true roots. He succeeded in causing the root-like organs in a rhizome of the *Cynomorium* to penetrate the seeds of *Atriplex nummularia* and to become parasitic on that plant. The author believes that the plant has acquired parasitic habits in consequence of the difficulties presented in the way of its propagation by seed.

Prof. G. Arcangeli† states that *Cynomorium coccineum* can carry on a parasitic existence on a number of shrubby and suffruticose, and even on annual plants.

Direct Absorption of Ammoniacal Salts by Plants.‡—Mr. A. B. Griffiths grew some bean seedlings (which had been immersed in copper sulphate solution to destroy nitrifying microbes, and washed with sterilized water), under antiseptic conditions in a sterilized solution containing certain ammonium salts together with others. At the end of four weeks the ammonia in the solution had sensibly diminished, and as there had been no direct atmospheric absorption of nitrogen, the ammonium salts must have been directly absorbed by the plant.

Aeration of Tissues.§—M. H. Devaux, in his résumé on this subject, states:—(1) That the internal atmosphere of all the massive tissues studied contained oxygen in notable proportion; in certain cases this proportion is nearly that of pure air. (2) The proportion of carbonic acid in the internal atmosphere is generally small. (3) The proportion of nitrogen is often different from that in the open air. (4) The internal and external pressures differ, sometimes in one direction, sometimes in the other. (5) Tubercles and fleshy fruits may be regarded as being formed of a very porous mass of tissue surrounded by a less porous envelope (examples, apple, orange). (6) It is probable that gas in a free state, which has passed through the surrounding envelope, penetrates to the deepest tissue. (7) Gas either in a free or dissolved state can traverse the external envelope. (8) The gaseous exchanges produced at the surface depend on the permeability and porosity of the peridermal membrane. (9) Oxygen enters principally by the pores,

* Bull. Soc. Bot. Ital., i. (1892) pp. 97-9. Cf. this Journal, *ante*, p. 67.

† Tom. cit., pp. 127-9.

‡ Chem. News, lxiv. p. 147. See Journ. Chem. Soc., 1892, Abstr., p. 229.

§ Ann. Sci. Nat. (Bot.), xiv. (1891) pp. 297-395.

while carbonic acid is exhaled through the membrane. (10) Humidity has a decided influence on the composition of the external membrane. (11) Slow or rapid desiccation diminishes the permeability, and leads to an accumulation of carbonic acid gas. (12) The variations in the pressure in the internal atmosphere are due to variations in the proportion of oxygen and carbonic acid. (13) A gaseous current through the pores is caused by differences between the external and internal pressures. (14) This current is one of the means by which nitrogen enters the internal tissues. (15) A constant purely passive circulation of nitrogen exists in all aerial plants. (16) Temperature modifies the composition of the internal atmosphere. (17) Light also produces its effect.

The author concludes by stating that the mechanism of exchanges can be classed under three headings:—(a) Effusion—Diffusion of free gas through the pores of the envelope under the influence of differences of pressure. (b) Dialysis—Diffusion of dissolved gas through the membrane of the envelope under the same influence. (c) Gaseous Current—General displacement of the total mass of mixed gases through the pores of the envelope under the influence of the difference of pressure which exists between the interior and exterior.

(3) Irritability.

Dependence of Sensitiveness on the Presence of Oxygen.*—Herr C. Correns has undertaken a series of experiments for the purpose of determining the correctness or otherwise of the ordinary view that the sensitiveness of organs is dependent on the presence of oxygen. Careful experiments made with a very exhaustive air-pump, and with precautions against sources of error which are described in detail, brought out a source of error in the older observations, viz. that the exhaustion of the air causes at the same time, through increased transpiration, the rigid condition of the organs due to drought.

The author classes movements of irritability under two heads,—those due to changes in the turgor only, and those due to growth, with or without previous change in turgor. Under the first head he investigated the movements of the leaves of *Mimosa pudica*, those of the stamens of *Berberis* and *Helianthemum*, of the stigma of *Mimulus*, of the filaments of *Centaurea*, and the sleep-movements of the leaves of *Oxalis* and *Leguminosæ*; under the second head, sleep-movements of the same kind, viz. those of the tentacles of *Drosera*, of the tendrils of *Passiflora*, and movements of geotropism and heliotropism.

The conclusion arrived at was that, at present, no general law can be stated for all these phenomena. The tentacles of *Drosera* are sensitive when the minutest trace of oxygen is present; while the tendrils of *Passiflora* require six per cent. of the normal amount of oxygen to bring out the sensitiveness to contact. With *Mimosa* the experiments were altogether indecisive; and this was no doubt partly due to constitutional differences in the species operated upon; since some seedlings, e. g. *Helianthus*, are geotropic with the least trace of oxygen, while others, e. g. *Sinapis*, only when a considerable proportion is present.

* Flora, lxxv. (1892) pp. 87-151.

But this is not the sole cause of the difference. Whether the oxygen acts directly or indirectly on the movements is still uncertain.

Caloritropic Phenomena of Roots.*—Herr J. af Klercker describes an apparatus for measuring the curvatures caused in growing parts of plants by unequal temperatures, and the results of observations made chiefly on *Pisum sativum*, *Faba vulgaris*, *Helianthus annuus*, and *Sinapis alba*. For the movements manifested in an organ under the influence of the conduction of a stream of heat on one side only of the organ, he proposes the term *caloritropic*, as preferable to *thermotropic*. At all events with the first three species named, he finds, as a uniform result, that the caloritropic phenomena increase in intensity with an increase of temperature.

Positively Geotropic Flower.†—Herr J. Wiesner describes what he regards as the first recorded instance of positive geotropism in a flower, in the case of *Clivia nobilis* (Agaveæ). The flower appears regular in the bud, but is monosymmetrical when fully developed. The movements of the flower dependent on growth are very complicated, the principal part being played by a form of nutation which is not distinguishable from positive geotropism. The flower, which is at first straight, ultimately curves, owing to the co-operation of this force with epinasty.

(4) Chemical Changes (including Respiration and Fermentation).

Transformation of Chlorophyll-grains into Amyliferous Leucites.‡—Prof. R. Chodat has followed out, in the pseudo-bulbs of *Calanthe Sieboldii* (Orchideæ) step by step, the transformation of grains of chlorophyll into leucites which produce starch. The colouring matter of the chlorophyll-grains becomes gradually limited to certain portions, and the grains of starch make their appearance first in the uncoloured portion.

γ. General.

Effects of Earthquakes on Vegetation.§—Sig. A. Goiran states that the effects of earthquakes on vegetation are to induce a more rapid germination of seeds, and a more rapid growth of the young plants, resulting in a greatly increased luxuriance of vegetation in the pastures, arable lands, vineyards, and shrubberies; and this is accompanied by an unusually deep green colour of the leaves. These results he believes to be due, not to the direct influence of the tremor, but to three secondary causes, viz.:—(1) The increased production of carbon dioxide; (2) the diffusion of nutrient fluids through the soil, acting as a kind of natural manuring; (3) the production of electricity, which has been shown by Aloï|| to be favourable to the luxuriance of vegetation. In other instances earthquakes have appeared to have an unfavourable influence on vegetation; but this is probably due to their having been associated with a long period of drought.

* Ofvers. k. Vetensk.-Akad. Förhandl. Stockholm, 1891, pp. 765-90 (8 figs.).

† Ber. Deutsch. Bot. Gesell., x. (1892) pp. 12-7.

‡ Ann. Sci. Nat. et Phys., xxiii. (1890) pp. 559-62 (1 pl.).

§ Bull. Soc. Bot. Ital., i. (1892) pp. 102-6. || Cf. this Journal, *ante*, p. 69.

Saccardo's Chromotaxia.*—Sig. Saccardo has published a little work which has for its object to give by means of the Latin tongue a definite term for the principal shades of colour of fungi, and thus avoid the ambiguity so frequently resulting from using modern colloquialisms. Of these shades of colour the author proposes fifty, a number quite sufficient for practical purposes.

As examples from yellow, luteus, flavus, citrinus, sulfureus, may serve to indicate the author's proposal, and though this looks somewhat severe at first sight, the author's brochure facilitates his scheme by giving the equivalent of the Latin terms in Italian, French, German, and English.

Though limited to fungi, this method of nomenclature is suitable for extension to other objects of natural history, and the same idea leads the author to suggest in a little note that the words or symbols employed in cryptogamic botany should have a precise and uniform signification.

B. CRYPTOGRAMIA.

Cryptogamia Vascularia.

Relationships of the Archegoniata.†—Pursuing his investigations on the phylogeny of the Archegoniata—in which he includes Gymnosperms as well as Vascular Cryptogams and Muscinæ—Prof. D. H. Campbell points out that the Anthocerotæ among Hepaticæ are probably the starting point, on the one hand of the Musci through the Sphagnaceæ, on the other hand of the Pteridophytes through the Ophioglossaceæ, the Anthocerotæ themselves being possibly derived from some such form as *Colcochæte* among Algæ. The prevailing types of existing forms of Pteridophytes, the Filicineæ, and among them the Polypodiaceæ, constitute in all probability a recent and highly specialized group; no unmistakable leptosporangiate remains are known earlier than the Mesozoic formations.

With regard to the phylogeny of Phanerogams, Prof. Campbell thinks it probable that Gymnosperms and Angiosperms may have had a different origin. The embryo of *Isoetes* much more nearly resembles that of a typical Monocotyledon than it does that of a Gymnosperm; while, on the other hand, the genetic relationship of Angiosperms to the Selaginellaceæ seems hardly doubtful. The assumption of a separate origin for the two groups of Angiosperms seems to the author quite unwarrantable. In all forms yet investigated, the uniformity in the essential structure of the flower, and especially in the development of the embryo-sac, seems to point unmistakably to a common origin.

Branching of the Aerial Roots of Selaginella.‡—According to Herr G. F. L. Sarauw the so-called "rhizophores" (Nägeli and Leitgeb) of *S. Martensii* and some other species of *Selaginella*, are true roots, the absence of a root-cap not being conclusive evidence of their cauline

* 'Chromotaxia seu nomenclator colorum polyglottus additis speciminibus coloratis,' Padoue, 1891. "Sur les règles à suivre dans la description des espèces végétales et surtout des cryptogames," Bull. Soc. Mycol. de France, 1891. See Bonnier's Rev. Gén. de Bot., iii. (1891) p. 553.

† Bot. Gazette, xvi. (1891) pp. 323-33. Cf. this Journal, 1890, p. 637.

‡ Ber. Deutsch. Bot. Gesell., ix. (1891) Gen.-Versamml. Heft, pp. 51-65.

character.* They spring either from the upper or from the under side of the leafy shoots, and at once direct their growth downwards. They are occasionally themselves transformed into leafy shoots. When they reach the soil, roots of ordinary structure force themselves through the swollen apex of the aerial roots, the outermost cells of the latter becoming converted into mucilage. This appears to be the result entirely of the absorption of water and not simply of contact. All the roots branch in a monopodial and not in a dichotomous manner. The branching of the roots in the soil appears to be in the first place the result of the moisture of the soil; the nutrient substances contained in it determining their further development.

Biology of Ferns.†—Prof. V. B. Wittrock has investigated several points in the biology of Ferns. He finds that complete desiccation of the frond for a considerable time in a sulphuric acid chamber does not (in *Polypodium vulgare*) inflict the least injury on the plant. The frond is able to absorb water in large quantities from the atmosphere directly through its surface. In many native species (of Sweden) such a desiccation takes place regularly in the winter; each species has its own special "dry position" of the leaves. In *Polypodium vulgare* the fronds assume a special "cold position" at the commencement of winter, consisting in the turgid segments of the fronds curving upwards, so that the frond takes the form of a cylinder. In many species of Polypodiaceæ the frond begins to die off from below, the apical portion remaining living and turgid, while it continues to absorb moisture directly from the air. In many species the bursting of the sporanges and dissemination of the spores takes place naturally in the winter or very early spring. In some species fronds which have lain for a long period in the herbarium can be restored to a turgid condition, in one case as much as 22½ months; while *Selaginella lepidophylla* showed signs of life after having been more than 11 years under a bell-glass, the water being absorbed through the stem and surface of the leaves. Revived herbarium specimens of ferns may put out new fronds and roots.

Ophioglossum.‡—M. S. Rostowzew has undertaken a careful examination of the structure and development of the vegetative organs in *Ophioglossum vulgatum*. In the bud-condition the single leaf of each year is almost entirely concealed by a sheath, and the orifice of the canal which traverses the bud is not situated at the summit of the sheath, but on its ventral side on a triangular prominence. The summit of the stem is cup-shaped, and the growing point is situated at the base of the cavity. The development of the leaf is very slow; its fertile portion or spike takes three years for its complete development. The initial cells of the sporanges are indistinguishable from the neighbouring meristematic cells. They divide into two, of which the interior is the archespore, while the exterior produces the wall of the sporange; this is ultimately composed of three layers of cells. The outermost layers of cells derived from the archespore are barren, and constitute an epithelium or tapete. The prothallium and embryo (sexual generation) of *O. vulgatum* are at present entirely unknown.

* Cf. this Journal, 1891, p. 765.

† Acta Horti Bergiani, i. 58 pp. See Bot. Centralbl., xlix. (1892) p. 132.

‡ Overs. K. Dansk. Vidensk. Selsk. Forhandl., 1891, pp. 51–82 (2 pls. and 17 figs.).

Algæ.

Kirchner's Microscopic Vegetation of Fresh Water.*—The second edition of this work is considerably enlarged, and, to a certain extent, re-arranged. The Phæophyceæ are now included, comprising the genera *Lithoderma*, *Pleurocladia*, and *Phæothamnion*, together with *Hydrurus* and *Thorea*. The object of the work is to enable the beginner, by means of the plates and descriptions, to identify the genus of any freshwater alga or fungus.

Cultivation and Conditions of Life of Marine Algæ.†—Dr. F. Oltmanns gives a number of details respecting the conditions of life of a variety of seaweeds, especially those of the Baltic, together with the best mode of preserving them under cultivation. While the proportion of mineral salts in the water, changes in its salinity, light, and temperature, are the essential factors in the life and distribution of marine algæ, a number of other conditions have also to be taken into account, especially the presence of a firm substratum to which they may become attached. Since the attachment is a purely mechanical one, the chemical composition of the substratum matters little. Sudden changes of temperature are especially to be avoided in their cultivation; and cold weather is more favourable than warm for their transport from their native element. A large number of species produce their organs of reproduction in the very early spring.

Reinke's Atlas of German Sea-weeds.‡—In the first and second parts of Heft 2 of this important work the following species are described, with 10 plates:—*Chorda filum* and *tomentosa*, *Isthmoplea sphaerophora*, *Stictyosiphon tortilis*, and *Spermatocchnus paradoxus*. The genus *Chorda* is made the type of a distinct group, *Chordeæ*, allied to *Scytosiphoneæ*. The author agrees with Kjellman in separating *Isthmoplea* from *Ectocarpus*, and thinks that *E. geminatus* should probably be transferred to it. In *Stictyosiphon tortilis* plurilecular sporanges only were observed; *S. subarticulatus* is entirely suppressed as a species, and even as a variety. The fructification of *Stictyosiphon* shows its near affinity to *Punctaria* and *Lithosiphon*, while *Striaria* belongs rather to the *Asperococceæ*, and *Coliodesme* to the *Dictyosiphoneæ*.

Freshwater Algæ and Schizophyceæ of Bohemia.§—Prof. A. Hansgirk makes large additions to the alga-flora of Bohemia, both as to species and as to new localities for old species. Among the new species described is *Micrococcus* (*Staphylococcus*) *epiphyticus*, forming a mucilaginous coating of a grey or greyish-yellow colour on various freshwater algæ.

Gonimophyllum, a new Genus of Florideæ.||—Mr. E. A. L. Batters describes a new British seaweed from the coast near Deal, the type of

* 'Die mikrosk. Pflanzen- u. Thierwelt d. Süßwassers. Th. I. Die Pflanzenwelt,' 2te Aufl., Braunschweig, 1891, xii. and 60 pp. and 5 pls. See Bot. Ztg., l. (1892) p. 113.

† Jahrb. f. Wiss. Bot. (Pringsheim), xxiii. (1891) pp. 349-440 (2 pls. and 1 fig.). Cf. this Journal, 1891, p. 777.

‡ See Bot. Centralbl., xlix. (1892) p. 25. Cf. this Journal, 1890, p. 216.

§ S.B. K. Böhm. Gesell. Wiss., 1891, pp. 300-65. Cf. this Journal. 1888, p. 626.

|| Journ. of Bot., xxx. (1892) pp. 65-7 (1 pl.).

a new genus *Gonimophyllum*, with the following diagnosis:—Thallus minutissimus, in *Nitophyllo lacerato* parasiticus, quasi duabus partibus compositus, inferiore parte (vegetativa) filis ramosis, monosiphoniis, irregularibus inter cellulas *Nitophylli* repentibus, et una cum cellulis distortis plantæ gestatricis pulvinar celluloseum efficientibus, constituta; parte altera (in qua fructus evoluti) libera, plana, oblonga, subrotundata aut plus minusve lobata, cellulis angulatis areolata avenia; fructus ut in *Nitophyllo*, sed soris totam paginam laminarum occupantibus. The new alga belongs to the same family, Delesseriaceæ, and even to the same tribe, Nitophylleæ, as the one on which it is endophytic.

Ædocladium, a new Genus of Ædogoniaceæ.*—Under the name *Ædocladium protonema* Dr. E. Stahl describes an alga representing a new type of Ædogoniaceæ found in wet places in a pine forest near Strassburg. The thallus consists of an aerial much-branched chlorophyllous and an underground colourless and slightly branched portion or rhizome. The cells of the green portion vary greatly in size, and the growth of the filaments is almost entirely apical. They display the formation of caps composed of cellulose-rings, characteristic of the Ædogoniaceæ. Persistent shoots containing a reddish-yellow endochrome are put out from the underground, less often from the aerial portions. The zoospores differ in no important respect from those of the other genera of the order; but, on germination, they do not form the attachment-disk characteristic of *Ædogonium*; they become attached by their green end, and the colourless end becomes the apex of the young plant, and it is here that the formation of rings takes place. The species is monœcious; no dwarf-males were observed; fertilization is effected by small antherozoids. *Ædocladium* differs from *Ædogonium* in its branched thallus; from *Bulbochaete* in its exclusively apical growth.

Ectocarpus and its Affinities.†—M. E. Bornet describes in detail the following species of seaweeds from the Mediterranean:—*Ectocarpus secundus*, *E. pusillus*, *E. globifer*, *E. crinitus*, *Haplospora Vidovichii*, and *Tilopteris Mertensii*. He points out that the statement that in some species of *Ectocarpus* the plurilocular sporanges are gametanges, while the unilocular are zoosporanges, rests at present only on three observations made on two species, and that the observers are not in accord as to the exact nature of the phenomena.

In *E. secundus* the antherid appears to be the homologue of the unilocular sporange, which has not been observed in this species. The distribution of the antherids is very irregular. Two species have been described under the name of *E. pusillus*. The true plant is that of Griffiths and of Harvey. The species described under this name by Kützing, Goebel, Falkenberg, Berthold, and Hauck, is identical with *E. globifer* Ktz. and *E. insignis* Crouan and Holmes. It is in this species that the conjugation of zoospores (gametes) has so often been described and figured.

The species variously named *Ectocarpus Vidovichii* Menegh., *E. geminatus* Menegh., *E. Meneghinii* Duf., and *E. crinitus* Hauck, is in

* Jahrb. f. Wiss. Bot. (Pringsheim), xxiii. (1891) pp. 339–48 (2 pls.).

† Bull. Soc. Bot. France, xxxviii. (1891) pp. 353–73 (3 pls.). Cf. this Journal, 1889, p. 675.

reality a *Haplospora* belonging to the Tilopterideæ. It has already been described by the author as *H. geminata*, but the earlier specific name *Vidovichii* is now substituted. It is the only species of that order yet known in the Mediterranean, and is at present confined to that sea. The antherids of *Tilopteris Mertensii* are described and figured.

M. Bornet considers that in the classification of these families it is preferable, at present, to use morphological rather than physiological characters. The Ectocarpacæ and Tilopterideæ are thus brought together, instead of being placed at opposite ends of the Phæosporeæ. It is difficult, again, to remove *E. Lebelii*, which has antherids, far from *E. simplex*, *globifer*, and *paradoxus*, in which the two kinds of sporange contain zoospores in all respects alike, or *E. secundus* from *E. granulosus*, which resembles it in so many points; while *E. pusillus*, with its immobile spores, is evidently nearly allied to the cæspitose species provided with zoospores.

Cosmocladium. *—According to Prof. C. Gobi, this reputed genus of Desmidiaceæ consists of nothing but a colony of small *Cosmarium*-cells united with one another by two parallel threads. He has been successful in following out the formation of the zygosperms, and their germination, and the formation of new colonies. A similar phenomenon occurs in another genus of desmids.

Fungi.

Harpochytrium Hyalothecæ. †—Prof. C. Gobi identifies this species of Chytridiaceæ, described by Lagerheim as the type of a new genus, with his own previously described *Fulminaria mycophila*. It inhabits the gelatinous envelope of other freshwater algæ besides *Hyalotheca*. The zoogonids, which have only a single cilium, dart, with extraordinary rapidity, in a curved path from one spot to another. As soon as they come into contact with the gelatinous sheath of an alga they come to rest, the cilium is transformed into a foot, and they invest themselves with a delicate membrane, becoming transformed into a sporange, which is usually straight, though occasionally sickle-shaped.

Ascomycetes. ‡—In this volume Dr. O. Brefeld completes his account of the Ascomycetes and of the Fungi generally. The history of development of all the important genera is given, and, in many cases, the characteristics of the species.

The Carpoasci (the higher division of the Ascomycetes) are divided into angiocarpous and hemiangiocarpous forms, the former comprising the Gymnoasci, Perisporiaceæ, and Pyrenomycetes, the latter the Hysteriaceæ and Discomycetes.

In the Gymnoasci the fructification has a loose incompletely closed envelope; the asci are formed in small tufts or hymenes on inconspicuous fructifications, the filaments of which are partly fertile, partly sterile.

* Arbeit. St. Peters. Naturf. Gesell. (Bot.) 1891, pp. 16-7. See Bot. Centralbl., xlix. (1892) p. 367.

† Arb. St. Petersb. Naturf.-Gesell. (Bot.), 1891, pp. 15-6. See Bot. Centralbl., xlix. (1892) p. 368. Cf. this Journal, 1890, p. 754.

‡ 'Unters. a. d. Gesamtgeb. d. Mykologie, Heft x., *Ascomyceten*,' Münster, 1891, 225 pp. and 9 pls. See Bot. Centralbl., 1891, Beih., p. 482. Cf. this Journal, 1891, p. 633.

The Perisporiaceæ have a close envelope without any ostiole, the spores becoming free by its decay. They are divided into the Erysipheæ, parasitic fungi, in which the mycelle bears conids, and the fructification is provided with appendages; the Perisporiaceæ, usually saprophytic, or, if not, with a brown septated mycelle, the fructification often sclerotoid; and the Tubercaceæ, the hypogæous forms of which have tuberous, fleshy, simple or chambered fructifications, the pericarp consisting of a strong pseudo-parenchymatous tissue, often of several layers.

The Pyrenomycetes have a close envelope with a distinct ostiole; the ascocarp or perithece forms a globular or flask-shaped structure. They include three families—(1) the Hypocereaceæ, in which the peritheces are soft and fleshy, of a light colour, and often combined into a stroma; (2) the Sphæriaceæ, with firmer darker peritheces, often united into a stroma quite distinct from the wall of the perithece; (3) the Dothideaceæ; the peritheces always imbedded in a stroma, and not distinctly separated from its tissue. (1) The Hypocereaceæ are distinguished by the frequency of secondary forms of fructification, both conids and chlamydospores. A new genus *Pyxidophora* is separated from *Hypomyces* by the absence of chlamydospores and stroma, and the simple structure of the perithece. (2) In the Sphæriaceæ the perithece is dark coloured, membranous, leathery, woody, or carbonaceous, but never fleshy; the secondary fructifications have the form of conids on free conidiophores, in layers, or in pycnids, or of chlamydospores. They include the following families:—Sordariaceæ, copricolous, with the peritheces not usually collected into a stroma; Chaetomiaceæ, with delicate fragile peritheces, bearing a characteristic tuft of hairs at the perforated apex; Trichosphaeriaceæ, with small peritheces clothed with hairs or bristles; Melanommaceæ, covering the surface of dead wood; Ceratostomaceæ; Cucurbitariaceæ, which sometimes produce pycnids; Sphærelloideæ, of which *Dematium pullulans* is possibly a conidial form; Pleosporeæ, the secondary fructification of which has the form of conids on free conidiophores or in pycnids, or of chlamydospores, the conids sometimes assuming the form of *Alternaria*; Massariaceæ, with free conids or chlamydospores and pycnids; Clypeosphaeriaceæ; Gnomoniaceæ; Valseæ, the pycnid-form of a genus of this class is known as *Cytispora*; Diatrypeæ, in which the conidial stromas are sometimes united into a coreme resembling *Isaria*; Melanconideæ; Melogrammeæ; Xylariaceæ, which form the most highly developed type of the Sphæriaceæ. (3) In the Dothideaceæ the asci are formed in cavities in the stroma, which take the place of the peritheces.

The Hysteriaceæ are distinguished by their apothecies opening when ripe by a longitudinal fissure in the form of lips.

In the Discomycetes the apothecia bursts at the apex into lobes. They are divided into six families:—(1) Phacidiaceæ; (2) Stictideæ; (3) Tryblidiaceæ; (4) Dermatiaceæ; (5) Pezizaceæ; (6) Helvellaceæ. (1) In the Phacidiaceæ the apothecies are formed in the interior of dead parts of plants, open at the apex, and expose the hymene as a flat disc. They are divided into Euphacidiaceæ and Pseudophacidiaceæ. (2) The apothecies of the Stictideæ are buried in the substratum; the hymene rests on a thin hypothecæ; the parenchymatous pericarp is waxy and of a light colour. (3) In the Tryblidiaceæ the apothecies are ultimately completely

exposed, and sometimes even shortly stalked. (4) In the *Dermatiaceæ* some of the apothecies are from the first completely exposed; the pericarp is membranous, waxy, or horny. They comprise four families—the *Cenangiæ*, with pitcher- or bowl-shaped apothecies, and a firm leathery pericarp; the *Dermateæ*, in which the apothecies have a short thick stalk; the *Patellariaceæ*; and the *Bulgariaceæ*, with gelatinous fructification.

In the *Pezizaceæ* the apothecia developes from a well-marked hypothecium on the surface of the substratum; it is at first closed, but opens out into the form of a pitcher or bowl; the pericarp is waxy or fleshy. They are divided into four families. (1) The *Helotiæ* comprise small fungi with sessile or stalked apothecies, which open out into a cup- or disc-shape. (2) In the *Mollisiæ* the apothecies are sessile and glabrous; the pericarp is parenchymatous. (3) The *Pezizæ* are the most highly developed family from a morphological point of view, and have large, fleshy, usually stalked apothecies. (3) The *Ascoboleæ* are distinguished by the mode of escape of the spores; the ascus stretches itself far out of the hymenium, an opercule is detached, and the spores, which are often numerous, are expelled with force through the opening.

In the *Helvellaceæ* the hymenium covers the outside of large fleshy erect hymenophores, of various forms, sometimes club-shaped, sometimes resembling a hymenomycetous fungus.

With regard to the phylogeny of Fungi, Dr. Brefeld considers that the *Algæ* and Fungi probably sprang in two distinct lines of descent from the *Schizophyta*. The lowest division of the Fungi is the *Phycomyces* (*Zygomycetes* and *Oomycetes*). From these are descended the *Mesomyces* (*Hemiasci* and *Hemibasidii*); and from these again the highest division, the *Mycomycetes* (*Ascomycetes* and *Basidiomycetes*).

New Genera of Fungi.*—MM. E. Bommer and M. Rousseau describe a number of new species of Fungi from Belgium, together with the following new genera, belonging to the *Ascomycetes*:—

Marchalliella. Peritheces superficial, glabrous, without an opercule, bursting irregularly when ripe, without subicules. Asci ovoid, 8-spored; spores brown, 2-celled. Related to *Zopfia*, but distinguished by its glabrous peritheces, and the spores not being apiculate. *M. zopfellioides*, on a pine-board which had been treated for two years with manure.

Psammia. Forming mucilaginous lumps of an olive colour beneath the epiderm. Conidia colourless, cylindrical, septated, coalescent at their base, radiately diverging, and forming nearly hemispherical heads. Related to *Prostemiella*. *P. Bommeriæ* on leaves of *Ammophila arenaria*.

Taphrina.†—Herr E. Rostrup describes twenty species of *Taphrina*, natives of Denmark, including two new species, *T. Githaginis*, parasitic on *Agrostemma Githago*, and *T. lutescens* on *Lastrea Thelypteris*. He states that the mycelium of *T. Pruni*, *Cerasi*, *Cratægi*, *deformans*, and *insititiæ* hibernates in the branches, that of *T. epiphylla*, *Ulmi*, *bullata*, *Tosquetii*, and *betulina* in the buds.

* Bull. Soc. Roy. Bot. Belgique, xxix. (1890) pp. 3–100.

† 'Taphrinaceæ Daniæ', Kjöbenhavn, 1890, 21 pp. See Bot. Centralbl., xlix. (1892) p. 125.

Saprophytic Fungi on the Beet.*—MM. E. Prillieux and Delacroix find that when plants of *Beta vulgaris* are attacked by the very destructive parasitic fungus *Phyllosticta tabifica*, a number of saprophytic fungi make their appearance on the decaying leaf-stalks, and among them the following new species:—*Sphærella tabifica*, *Ascochyta Betæ*, *A. beticola*, and *Diplodia beticola*. The first of these is probably the pycnid-form of *Phyllosticta tabifica*.

Parasitism of Botrytis cinerea and Cladosporium herbarum.†—In connection with the *Botrytis* epidemic of *Gentiana lutea* in the Jura, MM. E. Prillieux and Delacroix communicate some further cases in which the fungus, hitherto considered harmless, shows itself in its parasitic guise. Hyacinths and peonies were infected with the conidia of *Botrytis* taken from dead lettuce-leaves. Flowers and stalks were overrun by the mycelle and killed, later on numerous conidiophores appearing on the dead organs. *Listera ovata* was also found to be overrun by this fungus, and grape-leaves were seen deformed by the *Botrytis* and covered by conidiophores.

It also seems probable that *Cladosporium herbarum*, especially in the form *C. fasciculare*, becomes parasitic in the leaves of various important plants such as the raspberry and apple, in the former spreading from the median to the secondary nerves, and penetrating within, and in the latter seated along the edge of the leaves. Whether the last instances are cases of *post hoc* or *propter hoc* remains to be proved.

Anthraxnose of Cotton.‡—According to Prof. G. F. Atkinson, the disease known as anthraxnose of cotton is produced by a hitherto undescribed fungus *Colletotrichum Gossypii*, which attacks the green capsules, and appears also on the leaves in the form of a scurf. It is often accompanied by *Cercospora gossypina*. The unicellular spores, rose-coloured in the mass, are abstricted from the end of short colourless basids. The mycelle gives birth to sclerote-like bodies either imbedded in the tissue of the fungus or on the surface of the host. Secondary spores are also produced under unfavourable conditions.

Fungus-parasite on Barley.§—Herr O. Kirchner describes the disease in barley produced by *Helminthosporium gramineum*, which causes brown spots on the leaves and abortion of the ears. The conidia are large and many-celled, having sometimes as many as eight septa. The disease does not appear to attack other cereals.

Diplogramma, a new Genus of Lichens||—Herr J. Müller describes thirty-seven new species of Lichens from Queensland, together with the new genus *Diplogramma*, most nearly allied to *Ptychographa*, with the following diagnosis:—Thallus obsoletus; gonidia cum cellulis substrati mixta, globosa, viridia; apothecia gymnocarpica, lirelliformia, duplicia, quasi e lirellis duabus completis longitrorsum connatis *Opegraphæ* formata; perithecium parallele quadrilabiatum, hymenia duo parallela

* Bull. Soc. Mycol. France, vii. p. 19. See Bot. Centralbl., xlix. (1892) p. 338.

† Bull. Soc. Mycol. de France, vi. (1890) p. 134.

‡ Journ. of Mycol., vi. (1891) pp. 173-8 (2 pls.). See Bot. Centralbl., xlix. (1892) p. 280.

§ Zeitschr. f. Pflanzenkrankh., i. (1891) pp. 24-6.

|| Nuov. Giorn. Bot. Ital., xxiii. (1891) pp. 385-404.

gerens; hymenium utrumque labiis duobus consimilibus connivi-incurvis præditum; paraphyses connexæ; sporæ hyalinae, transversim divisæ.

Red Fermenting Fungus.*—Herr E. Kramer describes a fungus which produces a red colour in the fermentation of wine-must. It consists chiefly of roundish or oval cells, from $2\cdot7$ – $3\cdot5\ \mu$ in length, rarely more than three united together. On a solid nutrient medium the cells are enveloped in a gelatinous excretion, very soluble in water. The cells have a moderately thick cell-wall, and contain a round strongly refringent drop of oil. No formation of spores was observed. The red pigment appears only in old cells, more or less exposed to the air. It disappears immediately on application of water, dilute acids, or alkalies. It ferments dextrose readily; saccharose is first inverted, then fermented; maltose is readily fermented, but not lactose.

Spores of Uredinæ.†—Herr P. Magnus adduces arguments in favour of the view that the uredospores of the Uredinæ have developed out of teleutospores in consequence of their better adaptation for germination and dissemination on the most favourable host-plants. Those species in which there are no uredospores have not lost, but, on the contrary, have never acquired the property of forming them. Uredospores differ from uredomyces-spores in three points:—their wall is thinner, and is always provided with bristly warts; instead of a single apical germ-pore they have a transverse band of them; and as soon as they are mature, they put out their germ-filament which penetrates the host-plant. Between typical uredospores and teleutospores the author describes intermediate forms occurring in a large number of different species, as also between uredomyces- and uredospores. In *Uromyces scutellatus* the uredospores are formed at the same time as the teleutospores, instead of preceding them in their appearance, as is usually the case.

Indian Uredinæ.‡—The late Dr. A. Barclay gives the life-history of *Puccinia coronata* var. *himalensis*, including the æcidial, the uredo-, and the teleutospore-stages. The former occurs on *Rhamnus dahuricus*, the two latter on several grasses, *Brachypodium sylvaticum*, *Piptatherum holciforme*, and *Festuca gigantea*.

A new species is also described, *Puccinia Jasmini-Chrysopogonis*, the æcidium of which occurs on *Jasminum humile*, the uredo- and teleutospore-forms on *Chrysopogon Gryllus*.

In another paper§ Dr. Barclay traces the connection between the failure of corn-crops in India and the climatic conditions favourable to the luxuriant growth of rust and mildew, to the attacks of which he considers a large proportion of the destruction of the crops is due. The most destructive parasite is not, however, *Puccinia graminis*, but *P. rubigo-vera*, the life-history of which in India is but very imperfectly known, and may possibly be quite different from that in Europe, where the æcidio-form occurs on various species of Borragineæ. It appears to

* Oesterr. Landwirthsch. Centralbl., i. (1891) pp. 39–45. See Bot. Centralbl., 1891, Beih., p. 413.

† Ber. Deutsch. Bot. Gesell., ix. (1891) Gen.-Versamml. Heft, pp. 85–92 (1 pl.).

‡ Trans. Linn. Soc. Lond., iii. (1891) pp. 227–42 (1 pl.). Cf. this Journal, 1891, p. 635.

§ Journ. of Bot., xxx. (1892) pp. 1–8, 40–9 (1 pl. and 2 tables).

survive from year to year without any intermediate æcidial host, as the mycelle has the power of surviving in a perennial form in the roots of grasses.

In addition to his previous list of Uredineæ from the neighbourhood of Simla, the same author records * 32 fresh species, of which the following are new:—2 of *Uromyces*, 5 of *Puccinia*, 3 of *Phragmidium*, 1 *Xenodochus*, 1 *Melampsora*, 3 isolated æcidial forms, and 5 isolated uredo-forms.

Gymnosporangium.†—Dr. E. Fischer states that two species of *Gymnosporangium* are parasitic on *Juniperus Sabina*, *G. fuscum*, and *G. confusum*; and that the æcidia of the former occur only on species of *Pyrus*, those of the latter also on *Cratægus oxyacantha* and on *Cydonia vulgaris*. While the teliospore-generations of the two species resemble one another very closely, the æcidium-generations present well-marked differences.

Starch in Boletus pachypus.‡—M. E. Bourquelot has found that thin sections of the foot and cap of *B. pachypus* stained with iodine solution give a blue coloration, due to the presence of starch in the tissue. The occurrence of starch has been rarely detected in fungi.

Mycetozoa.

Massee's Myxogastres.§—Mr. G. Massee publishes an exhaustive monograph of the Myxogastres. He describes in detail the mode of growth and of reproduction of these organisms, and discusses at length De Bary's view that they belong to the animal rather than to the vegetable kingdom. He decides against this hypothesis, and considers that their nearest affinity is with the Fungi through *Ceratium*. Massee divides the Myxogastres primarily into four orders,—the Peritrichiæ, Columelliferæ, Lithodermæ, and Calotrichiæ, and the very numerous species are arranged under 40 genera. Under each species is given a diagnostic description, followed by its geographical distribution and its synonyms, and about 120 species are figured. A bibliography is appended.

Protophyta.

a. Schizophyceæ.

Xenococcus.||—Prof. A. Hansgirg now removes this genus of Schizophyceæ from the Chroococcaceæ to the Chamæsisphonaceæ, in the neighbourhood of *Pleurocapsa* and *Dermocarpa*, on account of its multiplication by gonids (kinetes), as well as by fission. The gonids are about 3 μ in size, and are formed, usually thirty-two in number, in marginal cells, which increase greatly in size and become transformed into gonidanges or coccogones. From *Dermocarpa*, *Xenococcus* is distinguished by its increasing also by bipartition; from *Pleurocapsa* chiefly by the form and structure of the stratum.

* Journ. Asiatic Soc. Bengal, lx. (1891) pp. 211–30 (2 pls.).

† Arch. Sci. Phys. et Nat., xxvi. (1891) pp. 490–5.

‡ Journ. Pharm., xxiv. pp. 197–9. See Journ. Chem. Soc., 1892, Abstr., p. 230. Cf. this Journal, ante, p. 245.

§ 'A Monograph of the Myxogastres,' London, 1892, 367 pp. and 12 coloured pls.

|| SB. K. Böhm. Gesell. Wiss., 1891, pp. 297–8. Cf. this Journal, 1888, p. 267.

Central Body in the Cell of Diatoms.*—Herr O. Bütschli has detected a large and conspicuous body, visible even in the living cell, in a large species of *Surirella*, in the form of a round dark granule lying in the hollow of the usually kidney-shaped nucleus. It appears to be the centre of radiating differentiations of the protoplasm, and is stained with moderate intensity by Delafield's hæmatoxylin.

B. Schizomycetes.

Structure of the Bacterial Cell.†—To determine the structure of the bacterial cell, Herr W. Wahrlich used twenty-four hour old cultures of *Bac. subtilis*, *tumescens*, *carotarum*, and others. These were examined in water, the preparations being stained and unstained. Dried cover-glass preparations were treated with sodium chloride, ferrocyanide of potash, and acetic acid, pepsin and trypsin, and 10 per cent. soda solution. In this way the author found that the plasma of the vegetative bacterial cell consists at least of two substances: one of these may be said to form the basis. It possesses a honeycombed structure, and from its micro-chemical reactions is linin; while the other substance, which is found as deeply staining granules within the former substance, corresponds to chromatin. Cytoplasm appeared to be absent.

The process of spore-formation was also examined, and it was found that the small granules which make their appearance within the bacterial cell shortly before spore-formation are nothing else than chromatin. From this is formed the chief part of the cell-contents, while the linin is devoted to the exospore, and imparts to the spores their power of resistance to acids and alkalis.

The conclusion of the article is devoted to a comparison of the bacterial cell at different periods of its existence with the cell-nucleus of more highly organized cells at their various stages of development, and a noteworthy analogy is established between the two, the author's view being that the cells of the bacteria examined by him are really cell-nuclei.

Effect of Light on Bacteria.‡—Dr. T. Geisler, who has made experiments as to the effect of light on bacteria, chose for the purpose the typhoid bacillus, and cultivated it in 10 per cent. gelatin. From these experiments he concludes that a qualitative difference between the effect of the sun and electric light cannot be perceived, but a quantitative difference exists, the sunlight having a greater inhibitory effect on the development of *B. typhosus* on gelatin than the electric light. The light, chemical, and heat rays of both electric and sunlight act harmfully towards bacterial growth; and, with the exception of the red rays, all the rays of the electric and solar spectra inhibit the growth of the typhoid bacillus, and this inhibitory effect is all the more powerful, according as the refractive index increases, and the wave-length of the corresponding rays becomes smaller.

* Verhändl. Nat.-hist.-Med. Ver. Heidelberg, iv. See Bot. Centralbl., xlix. (1892) p. 82.

† S.A. aus Scripta Botanica, 1890-1, 30 pp. (3 pls.). See Centralbl. f. Bakteriöl. u. Parasitenk., xi. (1892) pp. 49-50.

‡ Centralbl. f. Bakteriöl. u. Parasitenk., xi. (1892) pp. 161-73.

The unfavourable action of electric and sunlight on the growth of the typhoid bacillus on gelatin is not to be ascribed to the direct action of the light upon the bacilli themselves, but upon the changes set up in the media, and it is suggested that these changes may be due to the air becoming ozonized under the influence of the light-rays.

Mixed Cultivations.*—To verify the constant occurrence of a certain microbe, to be intimately acquainted with its morphology and biology, are, says M. Nencki, insufficient data for asserting that this particular microbe is the sole cause of the disease; indeed, if this were so, dealing with pure cultivations, say of cholera, diphtheria, &c., would be extremely dangerous for the bacteriologist. The author then states that in connection with the bacillus of symptomatic anthrax there is found a facultative anaerobe, *M. acidi paralactici*, and examination of the action of these microbes towards sugar showed that the bacillus acting alone formed from grape-sugar butyric acid, then acetic acid, and the optically inactive lactic acid, while the micrococcus when alone decomposed the sugar into paralactic acid. If, however, the sterile sugar solution were inoculated with both microbes at once, the ferment action was much more rapid, and the fermented fluid contained, besides the metabolic products peculiar to both microbes, a considerable quantity of butylalcohol. Hence the simultaneous action of two microbes is capable of producing a compound which neither alone is able to develop.

From this point of view the author explains disease; it is, in fact, due to a mixed infection, a symbiosis of micro-organisms, none of which alone would be able to produce that succession of morbid phenomena, but which, when acting in concert, bring about a condition recognizable as a specific disease, and he supports his argument by pointing out that the cholera bacillus alone is unable to call forth the typical cholera asiatica.

The author is of opinion that the present tendency of inducing alcoholic fermentation by means of pure cultivations of yeasts will in time be supplanted, since he has noted that when two different kinds of Schizomycetes act on sterile grape-sugar solution, they do so more energetically when in co-operation than when alone.

In contrast to this symbiosis and the results of mixed cultivations may be set those of enantibiosis; this is indeed nothing but a symbiosis, but the action of the microbes, instead of being an intensifying one, is neutralizing; for example, pure cultivations of two different microbes acting alone on albumen will decompose it most energetically, but when acting in combination the fermentation is not only less active, but in a few days ceases altogether.

Bacteriological Examination of Drinking-water.†—Dr. A. Reinsch records the results of a series of experiments made with Elbe water. The cultivation medium used was Koch's 10 per cent. meat-pepton-gelatin, and the object of the experiments was to determine, if possible, the proper alkalinity for this medium, the text-books merely stating that the reaction should be slightly alkaline. The author gives two tables in which are drawn up the results from adding definite quantities of

* Centralbl. f. Bakteriol. u. Parasitenk., xi. (1892) pp. 225-8.

† Op. cit., x. (1891) pp. 415-8.

Na_2CO_3 to 10 ccm. of slightly alkaline nutrient gelatin. The first column gives the amount, the second the result, in the number of germs which developed. In two tables are contrasted the maximum and minimum results from a series of eight experiments.

In Table I. the optimum amount of Na_2CO_3 is 0.01008 grm., 2976 germs developing; in Table II. it is 0.0212 grm., the number of germs being 740. In a third table the rapidly diminishing number of germs from adding definite quantities of tartaric acid is shown.

From his experiments, which are certainly suggestive, the author concludes that it is advisable to impart a definite alkalinity to nutrient media when used for the bacteriological examination of drinking-water, and points out that the ordinary method of determining the alkalinity of the media, by the use of litmus paper, is fallacious, since the alkalinity of these papers is variable.

Influence of the quantity of Tubercle Bacilli injected on the course of the disease in rabbits and guinea-pigs.*—The oftentimes observed chronic course of tuberculosis in inoculated guinea-pigs, and the frequently negative results in rabbits, M. Wyssokowitch refers to the small quantity of the tubercle bacilli injected rather than to a diminished virulence. His experiments show that the quantity of inoculated bacilli exerts a considerable influence on the development of the tuberculosis, especially in less sensitive animals. The fewer the tubercle bacilli injected, the slower as a rule was the course of the disease.

Defensive Proteids of the Rat.†—Not long ago Mr. E. H. Hankin directed attention to a class of proteids which possess a germicidal action, and which he termed "defensive proteids." It seemed possible that these bodies were the cause of the germicidal action of the blood-serum, and, if so, it might be expected that rat's serum owed its bactericidal properties to a similar substance, and as Behring ascribed this property to the alkalinity of some unknown base, it was further not improbable that this as yet unisolated substance possessed an alkaline reaction. Now it had been already determined by Kühne and Chittenden and Martin that such alkaline proteids exist. All three are albumoses. To obtain these bodies the simple method of dialysing was resorted to, and the toxic albumoses thus isolated differed from the albumoses of peptic digestion by their alkaline reaction. By this method the author isolated from the spleen of the rat a proteid which destroys bacteria and possesses an alkaline reaction.

From his experiments the author concludes that there exists in the spleen and serum of the rat a basic body which is distinguished from all known bases by the fact that it is insoluble in alcohol and distilled water and is not dialysable. It is a basic body belonging to the albuminoids and more strictly to the globulins. This globulin possesses a germicidal action, and it is due to its presence that the serum of the rat owes its power of destroying anthrax bacilli. Apparently, the immunity enjoyed by the rat to anthrax and diphtheria is, partially at least, brought about by the power of the rat-body to produce this substance.

The germicidal property of this substance can exist not only without,

* Trans. Internat. Med. Congress, 1891. See Bot. Centralbl., xlvii. (1891) p. 328.

† Centralbl. f. Bakteriöl. u. Parasitenk., ix. (1891) pp. 336-9, 372-5.

but within the body of animals sensitive to anthrax; hence it is possible that the protective proteids of the rat may be used as a remedy against anthrax.

Bacillus denitrificans.*—After noticing very shortly the history of denitrification, MM. E. Giltay and J. H. Aberson describe and discuss a microphyte which has the power of completely reducing nitrates to nitrites. Morphologically it appears to resemble the *Bacterium denitrificans* α and β of Gayon and Dupetit, and the fermentation it produces approaches that effected by those microbes—indeed the only difference between the action of *Bact. denit. α* and *Bac. denit.* seems to be that the former produces monoxide of nitrogen as well as nitrogen, both decomposing all the nitrate.

The physiological significance of the fermentation phenomena points to indirect aerobiosis—in other words they obtain sufficiency of oxygen by splitting up the nitrate and setting free the nitrogen, although it is possible that some of the latter is utilized as nutriment.

An interesting fact observed in the course of cultivation was that the presence of carbonate of lime favoured the denitrifying process, the crystals being covered with the bacilli.

The bacillus is a double rodlet 1.5 to $3\ \mu$ long and about $0.5\ \mu$ broad, but single individuals are also met with. It was isolated from earth and air on plates made from 10 per cent. gelatin and 0.2 per cent. infusion of earth; also by means of ordinary gelatin-bouillon and from the air by means of a medium containing nitrates. It was also cultivated in the following medium:—2 grm. nitrate of potash, 1 of asparagin, 2 of sulphate of magnesia, 5 of citric acid, 2 monophosphate of potash, 0.2 calcium chloride, and a couple of drops of perchloride of iron to the litre of water.

This medium was afterwards modified by substituting 2 grm. glucose for asparagin.

The addition of a small quantity of carbonate of lime was found to favour the reducing action of the microbe.

The method pursued by the authors for determining the kind and quantity of gas developed by this bacillus is then discussed at some length; a special apparatus for collecting the gas was devised and is depicted in an illustration. But the sum and substance of these experiments is that when the fermentation was concluded no nitrous or nitric acid or ammonia was found in the nutrient medium, the amount of nitrogen set free being (within fractional limits) equal to the quantity of this element contained in the medium.

Bacillus cyaneo-fuscus, a pigment-Bacterium.†—M. W. Beyerinck describes the life-history of a new pigment-bacterium which he has isolated from size and glue and also from "Edamer" cheese. The former are so vitiated by the action of the bacillus that they become black and do not set; in the cheese the bacillus sets up a disease known as the "blue disease." Yet these gelatinous and caseous substances are not the natural habitat of the micro-organism, its proper dwelling-place being earth and water; indeed, in their foreign abodes these

* Arch. Néerlandaises Sci. Exact. et Nat., xxv. (1891) pp. 341-61 (1 pl.).

† Bot. Ztg., xlix. (1891) Nos. 43-7 (1 pl. and 7 figs.).

bacilli are soon exterminated by the lactic acid ferment. The bacilli were cultivated in 10 per cent. gelatin to which $\frac{1}{2}$ per cent. pepton was added. The colonies were circular and surrounded by a zone of black pigment in which lime crystals were deposited. The bacilli are strongly aerobic, and liquefy gelatin. The individual rodlets are of variable size, from 0.2 to 0.6 μ long, and about half as thick. When alive they are mobile and colourless, when dead they become brown.

The chief characteristic of this organism is the formation of pigment, the colour of which varies with the stage of development. When cultivated in $\frac{1}{2}$ per cent. pepton solution the hue is first green, then blue, brown, and black, after this the solution loses its colour almost altogether.

On solid media the pigment is seen as blue or black areas of an irregularly spheroidal shape. Of course the formation of pigment is the most interesting characteristic of the micro-organism, and it serves as text for the author to discuss at some length chromogenic bacteria in general, and to propose a subdivision of them into chromophorous, chromoparous, and parachromophorous. In the chromophorous the pigment is an integral part of the cell-element and is comparable to the hæmoglobin in a red corpuscle. The chromoparous bacteria are, when alive, at first always colourless, the pigment being excreted as such or as a colourless chromogen.

In the parachromophorous bacteria the pigment, although obviously an excretion, adheres to the bacterial body as in the chromophorous bacteria.

As this organism was found to thrive at 20° C. if kept at this temperature for a short time only, but underwent some loss of vitality so that it was unable to be bred on solid media, although capable of being still cultivated in liquids, it is suggested that the virulence of many bacteria, e.g. those of cholera, erysipelas, and the like, might be retained successfully if they were cultivated in media not too strong in nutritive properties and at temperatures as low as possible, but suited of course to each organism.

Bactericidal Property of Rat's Blood.*—Behring having stated that the inhibitory effect of rat's serum on anthrax stood in causative relation to the immunity of rats to anthrax, MM. Metschnikoff and Roux performed a series of experiments in order to controvert the proposition. The results of the experiments certainly seem to indicate that rat serum possesses a powerful bactericidal property, yet the authors conclude that the bactericidal power of rat serum, very manifest "in vitro," does not explain the relative immunity of some of these animals to charbon. The preventive action that this serum exerts when it is injected in mice at the same time as the charbon virus is not due to an immunization of the mice, but to the direct influence of the serum on the bacteria, and also to its chemiotactic power on the leucocytes. In this case, as well as in all others studied by the authors, phagocytic phenomena play an important part.

* *Annal. de l'Inst. Pasteur*, 1891, pp. 479-86. See *Centralbl. f. Bakteriöl. u. Parasitenk.*, x. (1891) pp. 756-8.

M. Petermann, who has followed quite implicitly the procedure given by Ogata* for obtaining an immunity-giving substance from rat's blood, has failed to corroborate the statements of the Japanese professor, all his numerous experiments having quite failed.

Vaccinating Products of Liquid Cultures of Tubercle Bacilli.—In order to determine whether the soluble products of the tubercle bacillus favour or prevent the development of this micro-organism in the animal body, MM. J. Courmont and L. Dor made some experiments on rabbits by first injecting these animals (intraperitoneal and intravenous) with considerable quantities of tubercle cultures freed by filtration from bacilli, and then either simultaneously or at different intervals of time injecting into their veins virulent cultivations. For three days after the inoculation the weight of the animals diminished, but afterwards continuously ascended until they eventually weighed 500–1000 grm. more than before the inoculation. The control animals which had not received the culture-filtrate died of chronic tubercular arthritis. Of four rabbits which received a filtered and afterwards a virulent injection, two resisted the infection and retained this resistance seven months afterwards.

The authors conclude from the results of their experiments that the soluble secretion products of the tubercle bacilli in doses of 1 ccm. per cent. of the animal's weight do not exert any toxic action on rabbits, whether the injections have been made into the peritoneum or into the veins, and further that they possess the power of protecting the organism against the after infection of the very microbe which produced them.

Tolerance to Microbic Products.‡—MM. Metschnikoff and Roudenko, by means of forced injections of sterilized *Pyocyaneus* cultivations into rabbits, have succeeded in half the number of cases in producing certain tolerance to the virus of *Pyocyaneus*, a result opposed to that of Charrin and Gamaleïa, whose animals were rendered more resistant than normal. Analogous results were obtained with *Vibrio Metschnikovi* for guinea-pigs, although the experiments were at first in consonance with those of Gamaleïa, the vaccinated guinea-pigs being just as sensitive to fatal doses of the sterile poison as normal animals. These diversities appeared to depend chiefly on individual differences in the animals experimented on. As Gamaleïa had noted in 1889, the authors found that tubercular disease exercised great influence on the sensitiveness of the animals to the bacterial poison; for while in healthy guinea-pigs the reaction period for small or moderate doses of sterilized cultures of *V. Metschnikovi* was of short duration, the tuberculous guinea-pigs succumbed with considerable hyperæmia of the tuberculous foci.

The authors conclude from their experiments that tolerance to toxins may be possible, but this in no way shows that the existence of protective inoculation depends on this tolerance, since vaccinated

* Annal. de l'Inst. Pasteur, 1891, p. 506. Cf. this Journal, 1891, p. 797.

† La Province Méd., 1890, p. 594. See Centralbl. f. Bakteriöl. u. Parasitenk., xi. (1892) p. 114.

‡ Annal. de l'Inst. Pasteur, 1891, p. 567. See Centralbl. f. Bakteriöl. u. Parasitenk., xi. (1892) pp. 56–7.

animals in which no toxin-insusceptibility exists may be immune to the infection. In the latter case the specific source of habituation to the virus must be of cell-nature, the mobile phagocyte.

New Pathogenic Bacillus, causing Epidemics among Laboratory Mice.*—Dr. H. Laser describes a bacillus which was found to be the exciting cause of severe mouse epidemics. It is a small organism about twice as long as broad, and exhibits extremely lively movements, having terminal and lateral flagella. It was stainable with all the usual anilin dyes, but was decolorized by Gram's method. It grows well at ordinary temperatures, but better at incubation heat, and belongs to the acid-forming division. It thrives on the usual media, gelatin, agar, bouillon, potato, the gelatin being liquefied, and after three days the formation of gas bubbles was observed. From special experiments it was found that this bacillus belongs to the facultative aerobe class. Inoculation and feeding experiments made with pure cultivations showed that the bacillus was pathogenic to mice, guinea-pigs, and pigeons.

The author seems to think that his bacillus is allied to a group of organisms supposed to be the cause of ferret disease and the American and French swine plagues, one of the chief characteristics of these being that they are decolorized by Gram's method. The chief post-mortem appearance was great tumefaction of the spleen, and the virus was presumed to have been imported into the laboratory with carrots.

Cultivation of Bacillus Lepræ.†—Messrs. Kanthack and Barclay describe an apparently successful cultivation of *Bacillus Lepræ*, the bacilli having morphological, biological, and staining properties greatly resembling those of the leprosy bacillus. The microbe was isolated from fresh leprosy tissue in bouillon, and grew well on glycerin-agar. Great as the resemblances were, the behaviour towards nitric acid and methylen-blue seems to have excited the authors' suspicions, and they submitted their preparations to C. Fraenkel and Baumgarten, both of whom decided against it being *Bacillus Lepræ* on the grounds that it was not morphologically identical therewith, that its resistance to acids was too feeble, and that it grew too easily on artificial media. The arbitrators considered it the saprophytic *Bacillus epidermidis*, which in all probability is identical with Scheurlen's cancer bacillus.

Spirochæta anserina and the Septicæmia of Geese.‡—On some stations of the Transcaucasian Railway there appears every summer an epizootic among geese which die with typhoid symptoms, and Sakharoff has succeeded in finding in the blood of living (but not in dead) animals a microbe resembling *Spirochæta*. During the height of the disease these mobile microbes are frequently joined together in a stellate manner, and their appearance in the preparation is very transitory. Though mobile their motions are very stiff, and they do not exhibit the flexibility of those of *Polymitus avium*. From *Vibrio Metschnikovi* this

* Centralbl. f. Bakteriöl. u. Parasitenk., xi. (1892) pp. 184-9.

† Brit. Med. Journ., 1891, i. pp. 1222 and 1330; 1891, ii. p. 476.

‡ Annal. de l'Inst. Pasteur, 1891, p. 564. See Centralbl. f. Bakteriöl. u. Parasitenk., xi. (1892) p. 203.

parasite is distinguished by the absence of the comma form, and by its own characteristics; hence the author considers it to be a new species, and calls it *Spirochaeta anserina*. Pathologically it approximates to *Sp. Obermeieri*, and, like the latter, is not cultivable, but can be successfully inoculated on geese, while the attempts on pigeons failed, and those on fowls were doubtful.

Report on the Progress and Improvements in Bacteriological Methods since 1887.*—In a long drawn out and sketchy review of the numerous advances and improvements made in the various branches of bacteriological research, Dr. L. Heim alludes to the new methods which have been devised since Unna in 1887 performed a similar task of criticizing seriatim the various procedures then in vogue and appraising their value. Reports of this nature are valuable, because they mass together in a small compass a diffused collection of matter which is otherwise difficult of discovery, and also pass an opinion on the merits of the methods alluded to.

The article in question not only gives information as to the novelties and improvements in methods for demonstrating micro-organisms, their cultivation, the preparation of the nutrient media, alterations and modifications in the apparatus and instruments requisite for bacteriological research, but notices also the requirements for museums and for the equipment of expeditions, the methods for demonstrating and obtaining the products of bacterial metabolism, and those relative to the prevention and destruction of bacteria by chemical agents and by heat.

The more important and suggestive methods for the staining and cultivating of micro-organisms, for preparing nutrient media, and also the modifications and improvements in apparatus, have already been noticed in this Journal.

Koch's Annual of Fermentation Organisms.†—The first number of a new work devoted to the progress made in the knowledge of fermentation organisms has been issued under the direction of Dr. A. Koch—a sufficient guarantee that the Annual will contain all that is important. From the rapid advances and the increasing interest taken in ferments and fermentation organisms, it is obvious that a yearly summary of the work done is not only desirable but necessary.

The new Annual refers to text books, methods of research and examination, morphology of bacteria and yeasts, the various special fermentations, the much scattered literature of ferments and luminous bacteria.

Macé's Bacteriology.‡—The second edition of this excellent practical treatise on Bacteriology shows that its author tries to keep up with the ever advancing mass of facts daily brought to light in the study of micro-organisms. The present edition, revised throughout and much enlarged, contains 740 pages, and is illustrated by 201 figures, some of which are coloured.

After a short, too short, introduction touching the history, the place in nature, and the origin of bacteria, the work is divided into three

* Centraltbl. f. Bakteriöl. u. Parasitenk., x. (1891) Nos. 8-16.

† Brunswick, 1890, 8vo, 190 pp. See Bot. Ztg., xlix. (1891) p. 818.

‡ 'Traité pratique de Bactériologie,' par E. Macé, Paris, 1892.

parts, the first of which deals with generalities and technique, the second with classification and description, and the third with the bacteria with special environment.

The table of contents and a copious index help to render the treatise sufficiently complete for practical purposes.

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Zeitschr. f. Hygiene, XI. (1892) pp. 421-34.
- BOURQUELOT, E., ET —. GRAZIANI—Sur quelques points relatifs à la physiologie du *Penicillium Duclauxi*, Delacr. (On several points relative to the physiology of *Penicillium Duclauxi*.) *Compt. Rend. Soc. Biol.*, 1891, pp. 853-5.
- COURMONT, J.—Étude sur les substances solubles prédisposant à l'action pathogène de leurs microbes producteurs. (Study on the Soluble Substances which predispose to the Pathogenic Action of their Microbic Producers.)
Rev. Méd., 1891, pp. 843-4.
- DOMEC, F.—Contribution à l'étude de la morphologie de l'actinomyces. (Contribution to the Study of the Morphology of *Actinomyces*.)
Arch. de Méd. Expér., 1892, No. 1, pp. 104-13.
- EBERTH'S *Bacteriologische Wandtafeln*. (Bacteriological Wall-diagrams.)
 Parts 2 and 3, coloured, 109 × 109 cm., Berlin, 1892.
- FRAENKEL, C., U. R. PFEIFFER—Mikrophotographischer Atlas der Bakterienkunde. (Photomicrographic Atlas of Bacteriology.)
 Parts 12 and 13, Berlin, 1892, 10 plates with explanations.
- FRENZEL, J.—Ueber den Bau und die Sporenbildung grüner Kaulquappenbacillen. Ein Beitrag zur Kenntniss der Bakterien. (On the Structure and Sporulation of Green Bacilli of the Tadpole.)
Zeitschr. f. Hygiene, XI. (1891) pp. 207-36.
- GASPERINI, G.—Sopra una nuova specie appartenente al gen. *Streptothrix* Cohn. (On a new species of *Streptothrix* Cohn.)
Atti d. Soc. Tosc. di Sci. Nat., *Proc. Verb.*, VII. (1891) pp. 267-77.
- GESSARD, C.—Fonctions et races du bacille cyanogène (microbe du lait bleu). (Functions and races of *Bacillus cyanogenes* (microbe of blue milk).)
Ann. Inst. Pasteur, 1891, pp. 737-57.
- HESSE, W.—Ein neues Verfahren zur Züchtung anaërober Bakterien. (A new Experiment in the Culture of Anaerobic Bacteria.)
Zeitschr. f. Hygiene, XI. (1891) pp. 237-40.
- MAGNUS, P.—Ein kleiner Beitrag zur Kenntniss der parasitischen Pilze Kleinasiens. (Contribution to our knowledge of the Parasitic Fungi of Asia Minor.)
Bot. Jahrb. f. System., XIV. (1891) pp. 486-94.
- ROUX, G.—Précis d'analyse microbiologique des eaux. (Précis of the microbiological analysis of water.)
 18mo, Paris, 1891, 73 figs.
- „ „ Analyse bactériologique des eaux. (Bacteriological Analysis of Water.)
Ann. d'Hygiène Publ., II. (1891) pp. 401-18.
- „ „ Rôle de l'analyse bactériologique des eaux en hygiène. (Role of the Bacteriological Analysis of Water in Hygiene.)
Rev. Scientif., II. (1891) pp. 588-93.
- ROUX, M. G.—Identité du bacille d'Eberth et du *Bacterium coli commune*. (The Identity of Eberth's *Bacillus* with *Bacterium coli commune*.)
Lyon Méd., 1891, pp. 336-7.
- WURTZ, R.—Note sur deux caractères différentiels entre le bacille d'Eberth et le *bacterium coli commune*. (Note on two differential characters of Eberth's *Bacillus* and the *Bacterium coli commune*.)
Arch. de Méd. Expér., 1892, No. 1, pp. 84-91.



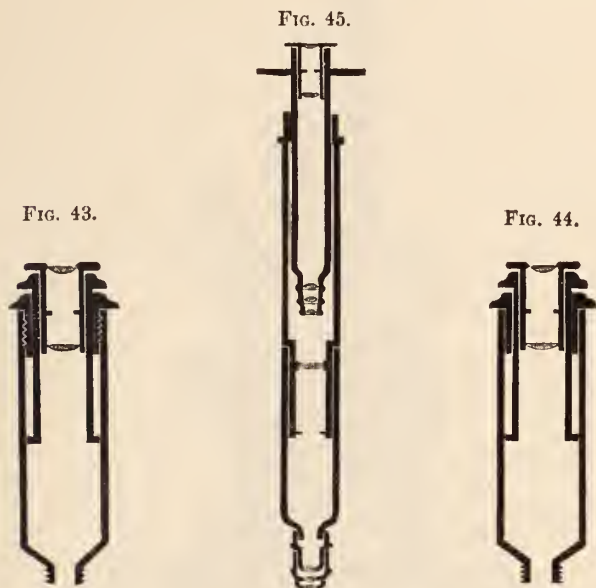
MICROSCOPY.

a. Instruments, Accessories, &c.*

(1) Stands.

A new Construction for the Microscope.†—Dr. A. Lendl remarks that in the use of the Microscope the chief consideration has hitherto been rightly paid to pure definition. The latest excellent objectives and immersion systems leave little to be desired in this respect, so that it is now time to seek to combine with this improved power of definition a much increased magnifying power.

The author attempts to effect this independently of the objective and without increasing the magnifying power of the eye-piece by a



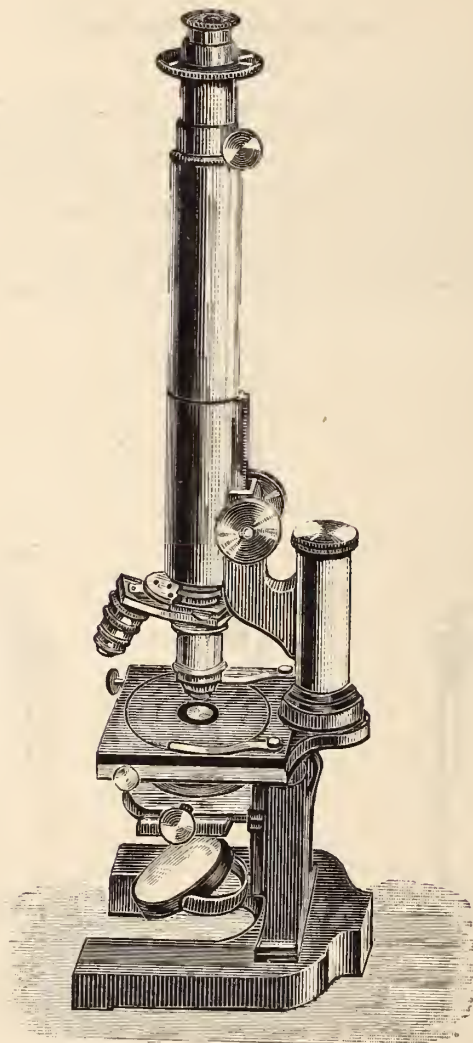
change in the construction of the Microscope. The eye-piece is removed and replaced by a second complete Microscope, so that the image formed by the objective is no longer observed by the eye-piece but by

* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

† Zeitschr. f. Wiss. Mikr., viii. (1891) pp. 281-90.

this auxiliary instrument. The author claims that by this means the resolving power and definition are not injuriously affected, and that the

FIG. 46.



field of view is not so much darkened as by the use of stronger eye-pieces.

In his experiments the author used a large Reichert Microscope. In this instrument on the upper end of the body-tube a ring (fig. 43) is screwed. In this is fitted a tube which carries the eye-piece and can be introduced and removed at will. For use with the auxiliary apparatus the ring is made to slide into instead of being screwed on the body-tube (fig. 44). It can thus be easily removed together with the tube carrying the eye-piece, and replaced by a longer tube containing at the lower end a condensing lens, and at the upper the auxiliary Microscope which is adjustable by rack and pinion (fig. 45).

The complete apparatus is represented in fig. 46.

It is not intended to make use of these very strong magnifications for continuous work, but only for the closer examination of details left in doubt by the ordinary method of observation. For such purposes the diminution of the field of view is no disadvantage.

As source of light the author uses the Koch-Wolz Microscope lamp combined with the Auer incandescent light, and also the electric incandescent light. The last allows of a magnification of from 8000 to 10,000 times.

The author has applied his method of observation in order to decide the vexed question of the shape of the pearls of *Pleurosigma angulatum*. With a Reichert homogeneous-immersion 1/20 and strong eye-piece No. V. the pearls give their usual hexagonal appearance, but by the use of the auxiliary Microscope with objective No. 2 and eye-piece I. or II., they are seen to be unmistakably rhombic in outline. The upper surface is curved and the edges and corners are truncated. The acute angles of the rhomb are rounded, so that on account of the deeper shadow, under lower magnification they give the appearance of two parallel sides of the hexagon. In some parts of the valve the pearls had disappeared, leaving however the very fine membrane on which they rested. This membrane was found to have kept the impression of the pearls as a rhombic pattern.

Surirella gemma was also examined. The striations are composed of small particles which give rise to the so-called "basket-like network." Each row appears like a string of pearls.* Here again in many cases pearls have disappeared, leaving a membrane marked by very fine striations. In the perfect specimen this striation does not coincide with, but is covered by the lines of the "basket-like network." With extremely high magnification, however, and by careful adjustment, it is possible to see first the network and then the striation. The combined images give the false appearance of elongated hexagons.

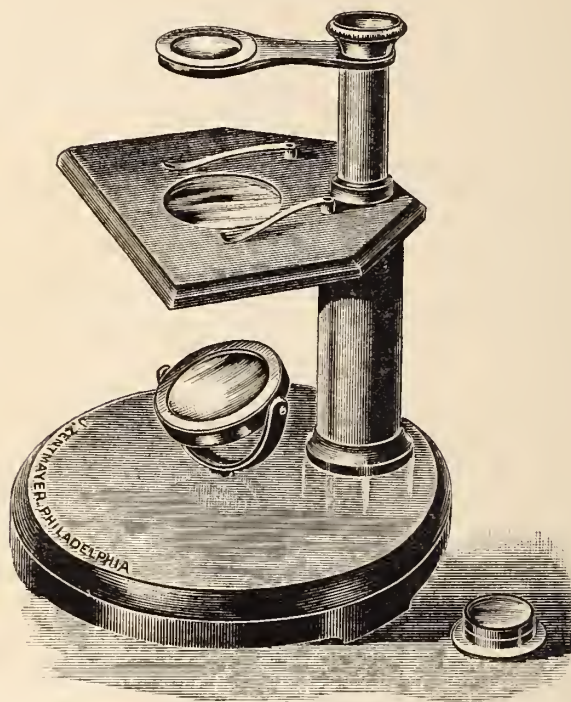
Zentmayer's Dissecting Microscope.†—This instrument, made primarily for botanical work, has a circular base 5 in. in diameter, and is made of polished brass. A stout pillar rises about 6 in. on one side, to which a broad stage (4 in. by 5) and a jointed arm for carrying the lenses are attached. A plane mirror is adjusted to the base beneath the stage. The latter carries spring clips, which are easily removed to

* See this Journal, 1890, Plate II.

† Amer. Mon. Micr. Journ., xiii. (1892) p. 2.

make room for a glass plate which fits the well of the stage. With the instrument come two lenses, 1 in. and $\frac{3}{4}$ in., which may be combined

FIG. 47.



to secure a $\frac{2}{3}$ -in. focus. The plan of this Microscope was suggested by Prof. J. T. Rothrock, of the University of Pennsylvania, and it is used in his botanical classes.

(2) Eye-pieces and Objectives.

Apochromatics.—Mr. Edward M. Nelson writes to us:—"In these days it becomes an important question whether a given objective contains fluorite or not. This can be easily determined by means of the polariscope. Applying this test, I find that in the 24-mm. objective it is the middle combination; in the 12-mm. it is the back, and the combination immediately behind the front lens; in the $\frac{1}{4}$ and in Powell's apochromatic condenser it is the middle and back combinations which have spar in them."

(3) Illuminating and other Apparatus.

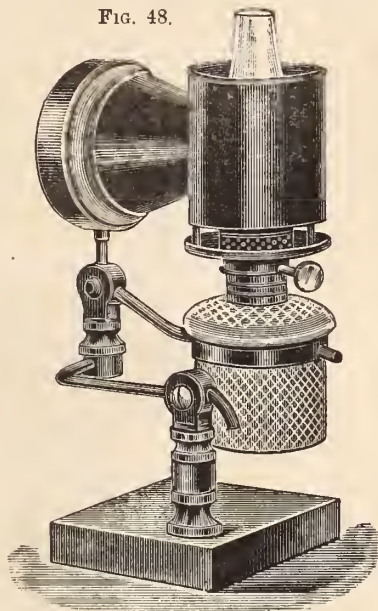
Stratton's Illuminator.*—This lamp is recommended as an addition to the paraphernalia of a microscopist. The supporting rods are con-

* Amer. Mon. Mier. Journ., xiii. (1892) pp. 1-2.

ected by stiff joints, which cause the lamp to remain in any position in which it has been placed, and the possible positions of elevation or of obliquity are such as to give light in any manner desired.

The oil-tank can be rotated in the holder, thus turning the edge or the broadside of the flame towards the Microscope, as necessity may require. The thick glass chimney as well as the flame is concealed by the metallic hood, well blackened, while a projection on the side of the hood directs the rays of light towards the bull's-eye. The latter, of unusual size (3 in. diam.), is supported by an independent support. The advantage of this is that the entire illuminating apparatus may be disconnected from the bull's-eye, or the light directed otherwise than through the bull's-eye if more general illumination is desired. The light from the flame is passed through a ground glass or blue glass at pleasure, and before reaching the bull's-eye. Strong or faint light, direct or oblique light, can all be had easily and without changing any adjustment of the Microscope. The 1/2-in. wick gives a very good flame, kerosene being used to burn. The arrangements for draught and for cleaning are good.

FIG. 48.



Some new Improvements applied to the mechanical part of the Microscope.*—M. Yves Delage, in collaboration with M. Nachet, has devised several improvements in the centering and other mechanical arrangements of the Microscope. In their new triple nose-piece or revolver the spring-catch consists of a cylindrical roller C (fig. 49), which is carried by a powerful spring R attached to the fixed piece of the revolver. This spring serves to press the roller into a semi-cylindrical groove hollowed in each of the arms of the movable piece. The groove, which has a radius a little less than that of the roller, so as to prevent all lateral motion, is cut in a small sliding carrier, which is kept pressed against a powerful spring by the conical screw-head F. By turning the screw the carrier is moved and the point of the movable piece displaced until arrested in front of the fixed roller. By this means the transverse adjustment is effected.

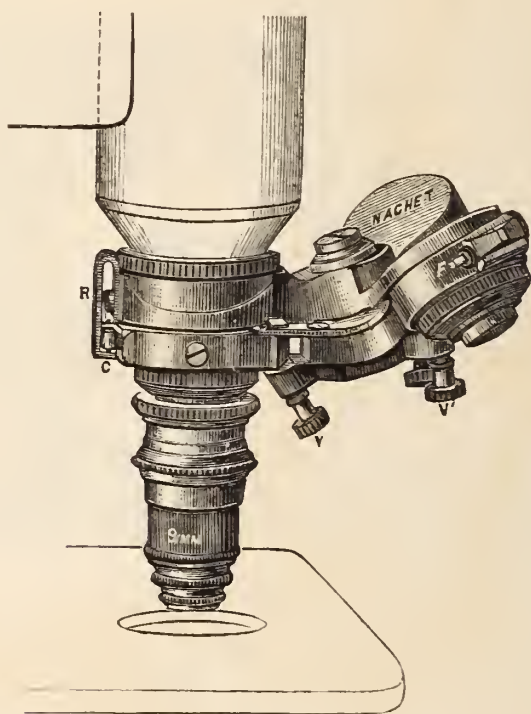
For the adjustment from front to back a movement of rotation about a horizontal axis is employed. For this purpose the central part of the movable piece is formed of strong tempered steel, flexible enough to yield beneath the pressure of a screw, but sufficiently rigid not to

* Arch. Zool. Expér. et Gen., x. (1892) pp. i.-ix.

vibrate. A screw *V* traversing obliquely the shoulder of the movable branch, presses on the terminal part, and bending the steel plate raises the objective, which thus describes a small circular arc from front to back.

Calculation shows that the harmful effect on the image of this angular displacement is quite insignificant. Thus, let *l* be the vertical distance between the axis of rotation and the object under examination, *L* the

FIG. 49.



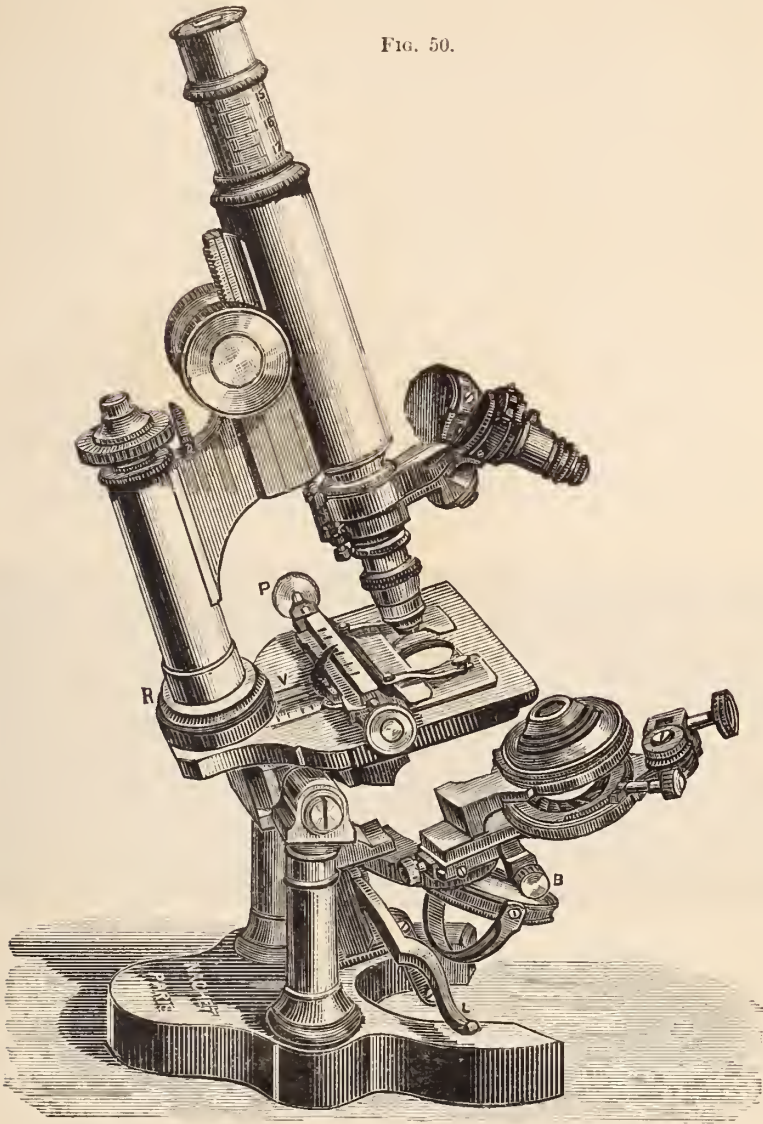
distance of the axis of rotation to the real image of the object formed by the objective, *d* the distance of the object to the axis, and *D* the distance of the real image to the axis. Then $d = Dl/L$. But *l* is approximately the length of the objective for all high magnifications; it is equal to about 30 mm. for a homogeneous-immersion objective; *L* is the distance of the base of the objective to the diaphragm of the eye-piece, i. e. about 150 mm. The ratio *l*/*L* is therefore about 1/5. At the most, *D* rarely exceeds 1 mm. when the objectives are screwed directly on the body-tube. This gives to *d* a value of 1/5 mm. On the other side, if *α* denote the angle through which the axis of the objective has turned, we have

$$\tan \alpha = \frac{d}{l} = \frac{1}{150} = 0.00566,$$

which gives for *α* a value less than 0° 23'.

The condenser (fig. 50) is movable on two rectangular axes, which allow of its adjustment in all directions in a horizontal plane. For this

FIG. 50.



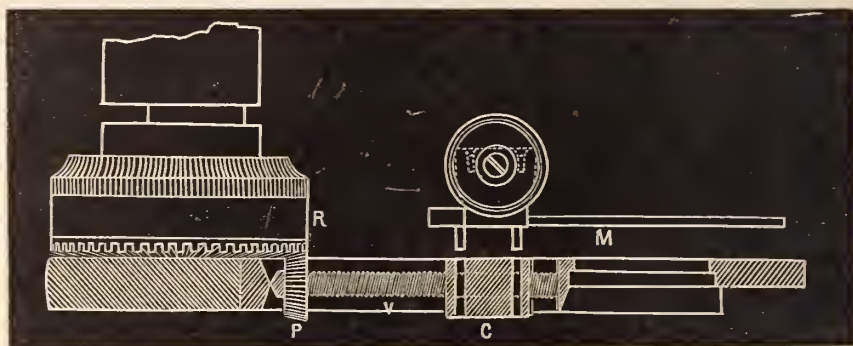
purpose it is fixed on a small sliding carrier, and a screw B' regulates the adjustment in the transversal direction. For the adjustment in the

direction at right angles, the movement of rotation by which the condenser in the older instruments could be drawn out from beneath the stage is utilized. The only addition is a screw B which works against a fixed projecting piece beneath the stage. This movement is, of course, not rectilinear, but on a circumference of 5 cm. radius an arc of 1 to 2 mm. coincides practically with its tangent. The vertical movement of the condenser with its iris-diaphragm is effected by a lever L, which acts on a carrier supporting the entire piece. The author considers the usual slow movement by micrometer-screw to be an absolutely superfluous complication.

The iris-diaphragm (fig. 50), which is fixed beneath the condenser at an invariable distance from the lower lens, is mounted like the condenser, except that the central position is determined by a catch. This central position, however, can be passed in either direction so as to obtain the effects of oblique light. A circular movement allows the obliquity to be directed in all azimuths.

In the adjustment of the instrument the invariable axis of the body-tube is taken as the basis from which to start. With this object, the Microscope, armed with eye-piece and objective screwed directly on the body-tube, is directed upon a cross-wire which is brought into the centre of the field by means of the movable stage described below. The condenser is then adjusted by centering either the summit of its luminous cone or the aperture of a small diaphragm above its upper lens. The iris-diaphragm is similarly adjusted, while it is opened just wide enough

FIG. 51.



to give the diameter of the field. The triple nose-piece with its objectives is then attached, and each arm is separately adjusted by observation of the aperture of the small diaphragm above the condenser which is brought to the level of the stage. For this purpose the observer, without removing the eye from the eye-piece, first works the screw F until the aperture is brought on to the axis of the field from front to back, and then the screw V until it is brought on to the transverse axis.

The movable stage (figs. 50 and 51), designed by the author, is intended to remedy some of the inconveniences of the ordinary apparatus. It possesses three advantages over the ordinary stage: (1) it can be

attached and removed in a few seconds; (2) it is movable in the transverse direction and from back to front; (3) it can be adjusted by one hand only. It has the following arrangement:—The fixed stage is traversed in the middle from back to front by a rectangular slit V (fig. 50), about 1 cm. wide, which extends from the column of the slow movement up to about 1 cm. from the aperture of the stage. In this slit is a horizontal micrometer screw V (fig. 51), which is provided on the extremity at the back with a vertical-toothed wheel P, working in a horizontal toothed wheel R, which is mounted on the column of the slow movement. The wheel R effects the movement of the micrometer screw V, while the latter acts on a small carrier C, which is flush with the stage, and, guided by the bevelled edges of the slit, traverses it from back to front. The movable stage is attached to this carrier by four vertical pins which fit into four corresponding holes in the carrier. It consists of a carrier movable in the transversal direction by means of a long micrometer screw terminated at each extremity by a screw-head P (fig. 50). Attached to the carrier in front is a plate M (fig. 51) cut away considerably in the centre in order not to hide the aperture of the fixed stage in any of its positions. This plate slides on two blunt ivory points, and the preparation is held firmly upon it by two small clips.

In the adjustment of the stage, the lateral movement is effected by the screw-head P on the right, which is held between the thumb and first finger of the right hand, while the movement from back to front is produced by the simple pressure on the wheel R of the thumb, which can be bent back without displacing the hand.

The two carriers are provided with scales graduated in millimetres, with verniers reading to $1/10$ mm.

The slide containing the preparation under examination has its position fixed by being fitted into a sort of rectangular box in which only two sides are retained, viz. the back and left.

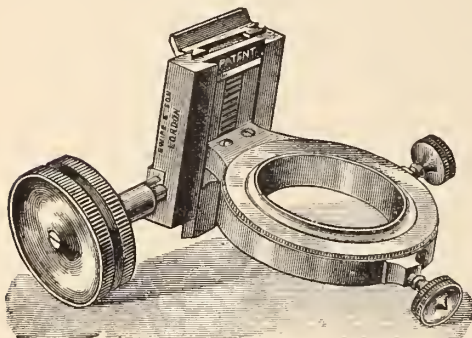
The transverse displacement is not of sufficient extent to allow of the examination of the whole length of a slide. To meet the case, however, when the preparation happens to be mounted at the end of the slide, the back edge of the rectangular box which holds the slide is dovetailed in a sliding piece, so that it can be displaced laterally by simple pressure of the fingers, and take three positions marked by a catch.

The author mentions, in conclusion, the Nachet eye-piece with very large field, and a convenient accessory to this in the shape of a small hood which can be placed over it. It is provided with a deep conical groove in which there fits a piece of black card, so cut as to protect the eye from external rays of light.

A new Fine-adjustment for the Substage.—Mr. G. C. Karop writes to us:—Every microscopist who works with modern high powers of large N.A. in combination with wide-angled condensers, soon becomes aware that the usual focusing arrangements of the substage are not sufficiently delicate; for it is necessary, if the best possible resolutions are required, that the image of the flame given by these condensers, whether dry or immersion, should be as accurately adjusted in the focal plane as the object itself. Although this is well understood, there are, so far as I am aware, but few devices for the purpose of obtaining this

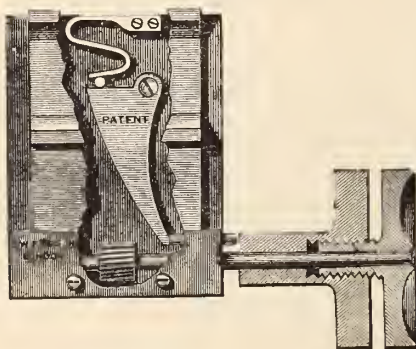
nicety of adjustment: Mr. Nelson's, a cone actuated by a milled head on the left, and pushing against a spring, fitted only to a few No. 1 Powell stands; a micrometer movement with the milled head at the end of the tail-piece, in the large Baker-Nelson model; and Messrs. Watson's, a

FIG. 52.



their well-known "Climax" fine-adjustment to the slide carrying the substage, but it is actuated by a milled head borne on the spindle to

FIG. 53.



lever movement with the head placed at the upper right-hand side of the main stage, in their Van Heurck instrument. Working as I do with one of Messrs. Swifts' stands, I suggested to them the advisability of providing a fine substage movement for their larger instruments, and they have carried out and improved upon my ideas with their usual mechanical skill. The movement essentially consists in the adaptation of

which is connected the pinion of the coarse or rack motion; in fact, so far as the arrangement of the two milled heads is concerned, it resembles the "Turrell" stage movement. One complete turn of the inner head raises or depresses the substage the $\frac{1}{125}$ in., so that very small fractions of this amount are readily obtainable, and as the two movements are close together and move in the same direction, manipulation is very easy. The "lift" is as nearly as possible central.

I submit this adjustment with confidence to those microscopists who have felt the want of some such contrivance when working with the highest class of optical appliances.

The Camera Obscura v. the Camera Lucida.*—Dr. Henry G. Piffard remarks:—"In drawing from the Microscope three methods are in vogue: (1) The observer studies the subject on the slide, and when he thinks he has the outlines and details sufficiently impressed on his mind, withdraws his eyes from the tube and commits the mental picture to paper, using both eyes in directing the movements of the pencil. (2) The observer, looking down the tube with one eye (usually the left), is enabled to see the virtual image by a sort of autoprojection delineated

* The Microscope, xii. (1892) pp. 92-3.

on a piece of white paper by the side of the Microscope. With the free right eye he guides the pencil in tracing on the paper the magnified map of the object. (3) In using the camera lucida a single eye is used for observing the object on the slide, as well as for guiding the pencil in tracing its reflected image. Method 1 requires a good memory and considerable skill as a draughtsman. No. 2, less skill is required, but the knack of doing it can only be obtained by practice. With No. 3, reasonably normal vision is a pre-requisite. The writer has for a long time, perhaps always, been affected with astigmatism and hypermetropia, to which advancing years have added presbyopia, and in consequence is unable to use the camera lucida with satisfaction. In No. 1, binocular vision is employed in the operation of drawing; in No. 2, monocular vision; and in 3, semi-ocular vision.

The inconveniences referred to may be avoided by a simple device, which the writer has of late used with some satisfaction, namely, a right-angled prism with silvered hypotenuse. This should be mounted with a short tube extending from one of the square surfaces, and of suitable size to enter the tube of the Microscope. A similar short tube of a size to receive the ordinary eye-piece extends from the other square face of the prism. If now the Microscope be placed with the tube horizontal and the prism case with eye-piece be inserted, the ocular pointed downward, an image of the object on the stage will be projected on a piece of drawing paper beneath, provided of course that there is sufficient illumination beyond the stage, and that no light reaches the paper except that coming through the objective. Personally I find this instrument much more convenient and satisfactory than the camera lucida. Mechanical micrograms must yield, however, to photographs; and the micrographic science of the future will seek the aid of the pencil less, and make more frequent use of the convenience and accuracy of photography. Bausch & Lomb made and mounted for me the prism described, and I have no doubt will be pleased to duplicate it for others."

KIRSCHMANN, A.—*Ueber die Herstellung monochromatischen Lichtes.* (On the Production of Monochromatic Light.)

Wundt, Philos. Stud., 1896.

Zeitschr. f. Wiss. Mikr., VIII. (1891) p. 420.

(4) Photomicrography.

Text-book of Photomicrography.*—The aim of the author in this text-book has been to give an account of the more important contributions to the now rapidly increasing literature of photomicrography. Nothing in this direction has been attempted since the appearance of Moitessier's excellent work in 1866. The author traces out the historical development of the apparatus and methods of photomicrography, and shows how the processes now in use were gradually perfected. The book is divided into eight sections. The first treats of the apparatus required for photomicrography from the general point of view of its production and adjustment; while the second deals with optical questions, and gives a history of the gradual development of objectives and eye-pieces. In the third section the various sources of light are described, and the

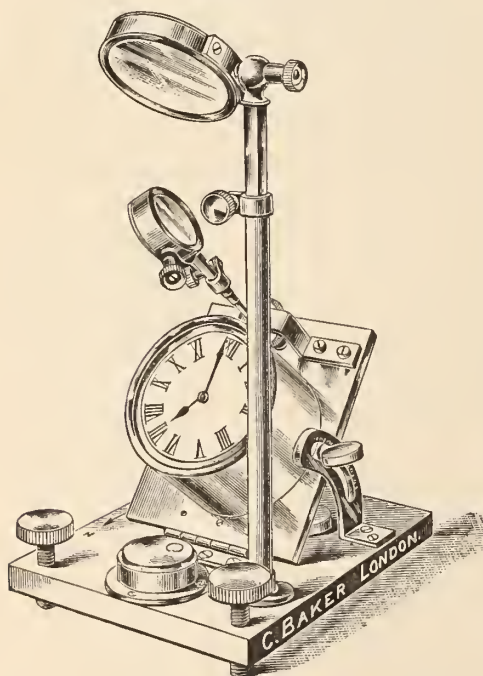
* 'Lehrbuch der Mikrophotographie,' by Dr. Richard Neuhaus, Braunschweig. See *Central-Ztg. f. Optik u. Mechanik*, xii. (1891) p. 282.

influence of the wave-length on the resolving power of the apparatus is discussed. The fourth section deals with the development of the methods of illumination by reflected and transmitted light. The other sections are devoted to the improvements in negative and positive processes, treatment of preparations, &c. The book is illustrated with 61 woodcuts, four autotypes, two photographic plates, and one photogravure.

Photomicrography of the Solar Spectrum and Absorption Spectra.*

—D. Joaquin Ma. de Castellarnau describes the method which he employs to obtain photomicrograms of the solar spectrum. In the disposition of the Microscope and spectral eye-piece which he adopts, a ray of sunlight is directed by a Prazmowski heliostat upon a mirror by which it is reflected along the axis of the Microscope placed in the horizontal position. The Abbe condenser projects an image of the sun upon the plane of the stage; the objective and field lens of the eye-piece form a

FIG. 54.



second image in the plane of the diaphragm, and lastly the front lens of the eye-piece produces a third image on the ground glass of the camera. Between the front lens and camera is interposed a direct vision spectroscope. The eye-piece employed was a special projection one of Zeiss which consisted of two lenses giving a system perfectly aplanatic and achromatic. For taking absorption spectra the transparent solid or liquid under examination is placed on the stage of the Microscope.

Portable Heliostat for Photomicrographic Work.

—This heliostat was exhibited by Mr. C. Lees Curties, at the meeting of November 18th last. It is made in the form suggested by Mr. T. Comber, and consists of a heavy

brass base with levelling screws and spirit-level. A clock, rotating a spindle once in twenty-four hours, is hinged to the base. This spindle can be set to suit the latitude of any place between 15° and 70° , and carries a small adjustable first surface mirror. A second similar mirror, but larger, on an adjustable stand, is also fixed to the base, and if set at half the angle of latitude of the place, reflects a horizontal beam

* *Cronica Scientifica*, Barcelona, August 1889, 7 pp. (sep. copy).

of the sun's image received from the small mirror in a northerly direction (fig. 54).

The mode of using the instrument is as follows:—Set the base as marked to the true north, level base, set small mirror to latitude as engraved on the arc at side of clock, and adjust this mirror to throw an image of the sun upon the centre of the larger mirror; if the photomicrographic apparatus be also placed due north and south, this image will be reflected through the Microscope to the focusing screen of camera or sensitized plate, whichever is in position.

Brass caps to protect the mirrors are provided.

Photomicrography of Podura-scales.—The following is the substance of the Hon. J. G. P. Vereker's remarks when exhibiting his preparations at the meeting of the Society on December 16th, 1891:—"I have been lately experimenting in photomicrography upon some scales of *Podura*, and have obtained results which seem to throw some light upon the structure of this difficult object.

The prints exhibited are from the negatives which I have obtained, and they appear to prove that the *Podura*-scale consists of a hyaline beaded membrane, having minute featherlets inserted in it as described by Dr. Edmunds in his paper to your Society.*

The photograph taken by Zeiss 4 mm. apochromatic lens gives a magnification of 480 diameters, and shows two different resolutions, one the well-known "exclamation" marks, and the other the scale covered with minute featherlets, which seem to stand out above the surface; it was on this latter resolution that the final focusing was done. To test this resolution, I took a photograph of a scale with dark-ground resolution, using for this purpose an immersion paraboloid, as shown to me and others by Dr. Edmunds, some years ago. For this purpose I used a water-immersion of Næth's No. 9 (about 1/13 in.), and this photograph seems clearly to show that they stand out above the basement as minute featherlets with a forked end. There is an indication of markings on their surface and a central midrib appears in some of them. I have tried to get further resolution of these featherlets by means of a 1/12 in. oil-immersion of Reichert's, but have failed, though the appearances would seem to indicate markings like a simplified *Lepisma* scale.

The standing up of the featherlets, as we may call them, is well shown under dark-ground illumination, as in this method the scale itself acts as the light radiant, showing the scale brightly illuminated on a black ground.

I also exhibit a photograph of a fine scale of speckled *Podura*, kindly lent to me for this purpose by Dr. Edmunds; it is taken by direct illumination with a 1/12-in. of Reichert's, N.A. 1.25, and is magnified about 900 diameters. It shows the beaded appearance of the hyaline base membrane of the scale. These markings exist in both *Podura plumbea* and speckled *Podura*, but are more strongly developed in the latter scale. The structure of the base membrane seems to be such that at the broadest part of the scale there are one or two rows of beads between the featherlets, whilst towards the base and top of the

* This Journal, xviii. (1877) p. 85.

scale the beads rather tend to form single rows. In many places the beads seem to be oval, but this I hold only to show that the beads are not properly separated. In the photograph the change from the oval to the double bead is easily traced, but whether this is optical or physical I am unable to say positively."

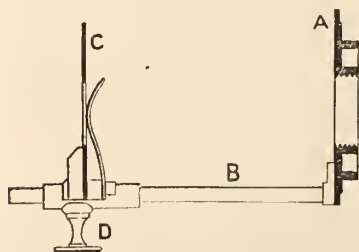
Mr. Vereker writes to say, under date March 15th, 1892, "I regret that I was away in the north of England when my paper on the *Podura*-scale was read, but if you will allow me I should like to answer one or two points in the discussion which followed.

I used a water-immersion of Nachet's, No. 9, which is nominally a $1/14$, but really I think a $1/13$, for the resolution with the immersion paraboloid, as owing to its great extent of correction I was able to work on a dry slide; and also because my $1/12$ oil-immersion of Reichert's would not work satisfactorily on a dry slide. I may say, however, for those who wish to use an oil-immersion, that Powell and Lealand's new apochromatic oil-immersion will work on a dry slide, and I inclose you a photograph of *Podura plumbea* on dark ground done with it. On the other hand I am doubtful whether there is much gain in so using an oil-immersion. As for isolated featherlets, I have just got a photograph with some, and with all due deference to others, there are featherlets missing on the scales on the slide; but I think, owing to the thickness of the pile in some places, it would be very hard to find out where a solitary featherlet was missing.

In reference to the beaded structure, it was photographed with direct light, and on the focusing screen the beads with Reichert's oil $1/12$ stand out very clearly against the rest of the scale; in the slide I used they were quite distinct from the featherlets, which indeed are not in focus at the same time as the beaded structure. The scale used was a specially selected one kindly lent by Dr. Edmunds and by a well-known preparer."

A simple Apparatus for Photomicrography.*—Mr. T. H. Muras describes an apparatus for use on an ordinary camera:—"Its chief advantage over the use of a Microscope with the camera being that the ordinary

FIG. 55.



use of the Microscope is not interfered with, so that the objects can be examined in the latter, and selected parts immediately photographed. A brass disc or adapter A, shown in section in the illustration, screws into a flange on the camera, and has a screw-threaded aperture to receive ordinary object-glasses. The disc carries a triangular rod B, about $3\frac{1}{2}$ in. in length, on which a square stage C slides, or can be clamped in any position by a screw D. The stage has a

central opening for light and springs for holding a slide. The back of the camera is movable to a distance of 20 in. by a screw; but an ordinary quarter-plate camera, with a rack and pinion, serves almost as well, the magnification then obtainable being less, owing to the shortness of

* Engl. Mechanic, lv. (1892) p. 61.

such cameras. Focusing is effected by clamping the stage so that the object is approximately in focus, and then moving the back of the camera as found necessary. This apparatus, which I designed and had made early in 1881, has been found to work very well with low powers, the illumination being effected by a paraffin lamp with one wick, the flame of which is focused on the object by stand condensers, with a blue cell interposed."

(5) Microscopical Optics and Manipulation.

Determination of the Focal Length of Optical Systems.*—Prof. Abbe describes a very convenient apparatus for determining focal lengths. Most of the methods for this purpose depend on the determination of the position or displacement of the images formed by the system to be tested. Such processes, besides being very difficult of application to systems of great focal length, are subject to considerable uncertainty. The method here suggested depends on the determination of the ratios of the apparent magnitudes of objects which are first observed directly and then by the system under examination. If this ratio for two objects at a distance from each other Δ is ρ_1 and ρ_2 , the focal length $f = \Delta (\rho_2 - \rho_1)$. To obtain great exactness a Microscope with Abbe diaphragm is used, in which only pencils with axes parallel to the axis of the Microscope are effective in the production of the image. The complete apparatus consists of a Microscope, with the adjustable stage of which two glass scales at a determined distance apart are rigidly connected. The system to be tested is mounted between the Microscope and scales. In passing from one scale to the other, separated from it by a distance of 50 mm., the objective is changed in order to facilitate the adjustment.

Microscopic Image of Transparent Bodies.†—Prof. Abbe explains the peculiarity of the phenomena which take place in the microscopic representation of bodies illuminated by transmitted light. In general, for each point of the object there is a corresponding point in the image. For bodies illuminated by transmitted light this is no longer the case. The rays from the source of light will on emergence from the object convert each point of its surface into a luminous point from which pencils are emitted in all directions. If, in the formation of the image, all of these pencils are made use of by the instrument, the image will then correspond to the object. This will happen when the angular aperture of the objective is sufficiently large to include all parts of the diffraction spectra formed on the boundary of the object. But where this is not the case different images may be obtained from the same object by blocking out certain of the diffraction spectra forming the image. It is also possible to obtain similar images from two different objects, if only those parts of the pencils which are common to both objects are made effective in the formation of the images, while the rest are blocked out.

Dr. Czapski demonstrated the truth of these remarks by some experiments on gratings made with a projection apparatus. By blocking out those spectra which resulted from the effect of every second line, the

* Zeitschr. f. Instrumentenk., xi. (1891) p. 446.

† Tom. cit., p. 447.

image of a grating became that of one with double the interval; and the images of two gratings of which one had double the interval of the other could in this way be made precisely the same. The image of two gratings at right angles to each other could, by making use only of the spectra lying in a diagonal direction, be converted into that of a grating with direction of the striæ along the diagonal of the gratings.

Investigation of the Action of Nicol's Polarizing Eye-piece.*—Dr. Sang in this paper, which is now printed for the first time, although read on February 20th, 1837, explains the mode of action of the ordinary Nicol's prism, showing how the ordinary ray is removed by total reflection at the surface of the Canada balsam. He determines by mathematical calculation the correct inclination of the ends of the prism, and finds that the obliquity of the faces in the natural rhomb must be diminished 4° instead of increased as suggested by Nicol, the inventor, in his first description of the prism. A long and complex piece of analysis then follows to determine the best form of rhomb in order that the extraordinary ray may not suffer any deflection in its path, and that the extent of field may be as large as possible. The author concludes with the suggestion that a polarizer might be constructed of two prisms of highly refractive glass, separated by a thin plate of Iceland spar cut at right angles to the axis.

In a note on the above paper, read November 23rd, 1891, Prof. Tait states how, at the urgent request of the late Dr. Sang, he brought before the Council of the Royal Society of Edinburgh the question of its publication. Whatever judgment may be passed on the rest of the work, the paper contains a very important suggestion in the proposal to construct a polarizer of two glass prisms separated by a thin layer only of Iceland spar. With regard to Dr. Sang's claim to priority in the explanation of the action of the prism, it is certain that many very similar attempts at explanation have been published since 1837, and the inventor himself supposed the action to be due to increase in the divergency of the two rays.

In place of the complicated piece of analysis in Dr. Sang's investigation of the limits within which the prism acts, Prof. Tait gives a much simpler demonstration. The employment of glass prisms separated by a thin layer of Iceland spar has been recently suggested by M. E. Bertrand.†

SCHELLBACK, H.—*Der Weg eines Lichtstrahls durch eine Linse.* (The Path of a Ray of Light through a Lens.)

Zeitschr. Phys. u. Chem. Unterr., IV. (1891).
Centralztg. f. Opt. u. Mech., XII. (1891) p. 97.

(6) Miscellaneous.

Dr. Van Heurck on the Microscope.‡—This book is intended to be a comprehensive treatise on the Microscope as constructed and used in its present form. In its treatment of the elementary principles of

* *Proc. Roy. Soc. Edinburgh*, xviii. (1891) pp. 323-40.

† *Comptes Rendus*, xcix. (1884) p. 538.

‡ 'Le Microscope, sa construction, son maniement; la Technique microscopique en général; la Photomicrographie; le Passé et l'Avenir du Microscope, par le Dr. Henri van Heurck,' 4th ed., Anvers, 1891, 8vo, 316 pp., text illust.

optics there is nothing in any sense new, and there is neither in this part nor the subsequent pages of the book any effort made to give any mathematical expression to the complex modern theories of microscopic vision. This will not diminish the value of the book to the less ardent student; but it will leave a proportion of those who desire to understand fully the principles of modern theory and practice concerning the Microscope still unsatisfied; of course the one might have been accomplished without detriment to the other. "*La théorie de la vision microscopique de M. le Prof. E. Abbe*" is given clearly, but scarcely as exhaustively as we are inclined to believe its importance at this time demands. At length the theory of Abbe has received the careful consideration its value demands; but this has also brought with it a criticism which cannot be ignored, and the value of which will only be seen after an equally careful consideration. Like all similar criticism it will only lead to what all earnestly desire, a more radical analysis, and a firmer establishment and more useful application of what will remain unshaken. But it is all the more needful that those concerned in the controversy should have before them, in as clear and exhaustive a form as possible, the details of the great modern theory of microscopic vision.

In dealing with the "general consequences" of the theory there is certainly a fearlessness and an assumption of the inevitable in regard to these "consequences," which practically conclude that they may in their smallest details be placed side by side with the demonstrated laws of light. We much prefer an open mind, and although we believe that the Abbe theory in the main must remain unshaken, Dr. Abbe has himself shown that there are points in detail which have needed modification.

In the use of the more powerful object-glasses Dr. Van Heurck has shown himself singularly competent, especially in regard to photomicrography; hence we are somewhat disappointed to find so limited a range of "test-objects" considered, especially as those he directs us to employ have been for so long in use. What we now need is objects that will specifically differentiate the qualities of the apochromatic objectives from their achromatic predecessors, especially when it is considered that for lined (or "dotted") objects the table so long and usefully printed at the back of this Journal gives the theoretical power of any lens.

We note that the pygidium of the flea is given with much commendation as a "test." No doubt it has its value for this purpose; but with the recent (apochromatic) objectives there is more discoverable than was taken as evidence of "test structure" a few years ago. The minute hair-like bodies covering the surface, and especially their mode of insertion, are among these.

Of course we have a slight reference only to the new object glass by Zeiss of N.A. 1.60, and Dr. Van Heurck's remarkable photomicrographs with it are reproduced. In regard to these it must be remarked that they can hardly be counted satisfactory, taken as they were with a condenser whose aberrations are of the most emphasized nature, and with no attempt at their correction.

The disqualifications of this remarkable objective are not referred

to or illustrated, but there is a final chapter, in the form of a translation of a paper by Dr. S. Czapski, which gives a suggestion for the possible enlargement of the practical N.A. of homogeneous lenses, which gives us the possibility of advancing to 2.0 or beyond it without the employment of the dense flint and high refractive media needed by the lens we have referred to. This communication has already appeared in English in this Journal, and indicates clearly the value of *true* monochromatic light which may increase a N.A. of 1.40 to 1.75.

There is a considerable chapter on "Photomicrographie." This, as a matter of course, is excellent, but is not exhaustive nor as specially critical in regard to instruments and methods as might be desired.

As must inevitably be the case in all general treatises on the Microscope, the chapter on the preparation and mounting of objects is suggestive, and, so far as it goes, useful, but inefficient. But the student may well be content, for many handbooks are now obtainable wholly devoted to the subject.

In regard to the important question of what a Microscope should be, what are its points of excellence, what is indispensable, and consequently what should be its general form and detailed construction, we do not obtain very definite conclusions. A large array of Microscopes are presented in an illustrated form, but they are mostly described, without being critically compared. We have, however, a figure of an instrument prepared by Messrs. Watson for Dr. Van Heurck, described and illustrated. We presume this will be more or less the expression of what the author desires in a Microscope. It is no doubt fitted with what are intended to be the latest improvements; but, to begin with, it would be held by most experienced workers, especially photomicrographists, that the stand is most defective from its form, involving lateral instability, and securing such stability as it possesses by weight rather than by construction. But this is secondary to the want of perfection in its fine-adjustment and the mode of centering in its substage, to say nothing of the awkward position of the milled head employed, apparently, in giving a fine-adjustment to the substage, and the great thickness of the stage itself.

The book is well printed, and fairly illustrated; it gives a brief history of the instrument it describes, and instructs the reader how to use it. It will be of service to many, and throughout gives valuable hints, as well as lucid instruction, to those who seek to understand how to use to the best advantage one of the most delightful instruments employed in the study of nature.

Text-book of the Microscope.*—This is one of the most practical books yet presented to the laboratory student. The aim is to enable him to understand his instrument in at least its broader principles, and thus to apply it intelligently to the study of histology. It cannot be doubted that there is, chiefly perhaps because of the great variety of subjects requiring to be dealt with in the medical curriculum, a deficiency of knowledge amongst students as to the principles and the optical laws involved in the construction and use of the Microscope. Prof. Gage

* 'The Microscope and Histology, for the use of laboratory students in the anatomical department of Cornell University, by Simon Henry Gage. Part I. The Microscope and Microscopical Methods.' 3rd ed. Ithaca, N.Y., 1891, 8vo, 96 pp. interleaved, 5 pls., text illust.

evidently feels this, and remembering the little time at the disposal of the student, has sought to condense and put in the most concise and practical form what it is well for him to know about his instrument in theory and practice. We cannot say that a student can consider his knowledge as either wholly satisfactory, or in any sense exhaustive, when derived from this book alone; but on the points in difficulty he can readily consult more exhaustive treatises. The illustrations are crude, but they are only intended to be diagrams, and are in the main made to convey the points specially emphasized.

On mounting there are some good practical hints, and there is a very useful bibliography, with an index completing the volume. We conclude that this book has a *raison d'être*, and will, especially in America, command a good audience.

Behrens' Tables for Microscopists.*—The appearance of this second edition of Behrens' useful tables will be welcomed by microscopists. The new edition forms really a new work, for few only of the tables of the original remain unchanged. In the preparation of this greatly enlarged edition, Dr. W. Behrens has had the assistance of several eminent authorities. The 76 pages of the first edition have been extended to 205, while the number of separate tables has been increased from 54 to 76. The arrangement of the tables remains very much the same as in the first edition. The most important addition consists in two long tables devoted to microchemical reactions, for botanical and mineralogical investigations.

Nature of Solutions and the Use of the Microscope.†—In a discussion on solution and pseudosolution, Mr. H. Jackson remarked that he had found in the case of lead hydrate that the Microscope revealed moving particles with an average diameter of $1/35,000$ in. Some, in the case of silver nitroprusside, were less than $1/100,000$ in. It is quite clear that it is impossible to call a liquid homogeneous because the Microscope fails to show structure. All that can be said is that the particles in water, if not visible with lenses of the greatest possible angle for water, are probably not much greater than $1/180,000$ in. in diameter.

The late Mr. W. W. Reeves.—The Fellows will hear with regret of the death of one of the most constant attendants at our meetings, and one well known, especially to the older Fellows, in consequence of his having been Assistant Secretary to the Society from 1868 to 1883. He has served on the Council since 1890. Our deceased friend died on the 18th of May last.

DUVAL, A.—*La technique microscopique et histologique.* (Microscopical and Histological Technique.) Paris (Baillière) 1891, 16mo, 43 figs.
SCHIEFFERDECKER, P., U. A. KOSSEL.—*Gewebelehre mit besonderer Berücksichtigung des menschlichen Körpers.* [Bd. II. von W. BEHRENS, A. KOSSEL U. P. SCHIEFFERDECKER, *Die Gewebe des menschlichen Körpers und ihre mikroskopische Untersuchung.*] (Histology, with special reference to Man (Vol. II. The Tissues of the Human Body, and their examination by the Microscope.) I. Abtheil., Braunschweig, 1891, 8vo, 414 pp., 214 figs.

* Behrens, W., 'Tabellen zum Gebrauch bei mikroskopischen Arbeiten. Zweite neu bearbeitete Auflage,' Braunschweig, 1892, 8vo, 205 pp.

† Proc. Chem. Soc. London, No. 104 (1891) pp. 178-9.

B. Technique.***(1) Collecting Objects, including Culture Processes.**

Mode of keeping Fresh-water Animals alive.†—Dr. J. Dewitz recommends the spreading of a piece of canvas or small dampened towel over the bottom and side of a plate on which the fresh-water animals are placed. They must then be covered with another wet towel and put in a cold room. The towels must be washed and wrung out every fourth day, and any dead specimens removed.

Antibacterial Value of Aristol.‡—In order to estimate the antibacterial value of aristol, Dr. Heller inoculated agar plates with *Staphylococcus aureus*, putrefactive bacteria, and anthrax. Some of the plates were covered with iodoform, and others with aristol. The capsules were then incubated at 37°·5 for 2–3 days in the absence of light, sufficient moisture being supplied by water placed in other capsules. No further development was found on the plates strewn with iodoform, but on those covered with aristol there was a luxuriant growth, except where the layer happened to be very thick, a result probably due to the mechanical exclusion of air. Hence it would seem that the antibacterial value of aristol is small, and, at any rate, not to be compared to that of iodoform.

Effect of Centrifuging on Bacterial Suspension, with special reference to the Dissemination of Bacteria in Milk.§—After having ascertained by experimenting with anthrax that an hour's centrifuging at the rate of 2000–4000 turns a minute was not detrimental to the vitality or the virulence of these organisms, Herr Scheurlen turned his attention to the behaviour of bacterial pure cultivations in suspension.

The results of centrifuging were found to depend on the mobility or immobility of the bacteria, the latter tending to be thrown out and to form a sediment, while some of the former, e.g. Cholera vibrio and *Proteus mirabilis*, remained suspended.

The author then examined the behaviour of the bacteria of milk when similarly treated. After centrifuging, the milk-scum, when tested by means of plate cultivations, showed, as was to be expected, a large number of colonies, while the number in the cream was also very great, and might even exceed that of the scum.

The author infers from the experiments that milk cannot be freed from its bacteria by centrifuging, for out of 2050 millions of germs in the whole volume of milk, only 18 millions were removed in the scum. About three-fourths of the number are transferred by the centrifuging to the cream, the remainder being in the buttermilk.

Most pathogenic microbes, such as anthrax, typhoid, and cholera, cling to the cream like the milk-bacteria, but tubercle bacilli were for

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, &c.; (6) Miscellaneous.

† Zool. Anzeig., xv. (1892) pp. 105–6.

‡ Arch. f. Derm. u. Syphilis, 1891, p. 840. See Centralbl. f. Bakteriologie u. Parasitenk., xi. (1892) p. 351.

§ Arbeit. a. d. Kaiser. Gesundheits-amte, vii. (1891) See Centralbl. f. Bakteriologie u. Parasitenk., xi. (1892) pp. 53–4.

the most part separated out, only a few remaining in the milk and cream.

Collecting Samples of Water for Bacteriological Analysis.*—Dr. W. Johnston describes in detail his method of obtaining samples of water from any depth, free from contamination and with great ease. The collecting apparatus, which is a modification of that invented by Prof. Ellis, is very ingenious. It consists of a framework holding a sterilized glass bottle, and so weighted that it can be lowered to the required depth. By pulling a string attached to the stopper the latter can be raised sufficiently to allow the water to enter. When the string is released, the stopper is instantly replaced by the action of a spring.

For further details of this simple and ingenious apparatus the original must be consulted.

Method of obtaining Pure Cultivations of Tubercle Bacilli from the Sputum.†—Dr. E. Pastor first ascertains if the sputum contains a good quantity of bacilli and relatively few foreign organisms; the patient is then made to repeatedly wash his mouth and the back of his throat out with sterilized water, and then to expectorate into a sterilized vessel. The sputum thus obtained is emulsified by shaking it up with sterile water, and any coarse particles filtered off with fine gauze. A few drops of the filtrate are then mixed with fluid 10 per cent. gelatin, care being taken that the medium is not rendered too cloudy. The still fluid gelatin is then poured out into plates, and these, just covered with a bell-jar, are left at the room temperature. In the course of three to four days colonies of bacteria spring up. By means of a lens parts of the gelatin which remain quite clear are then sought out. These are then carefully excised with a sterilized knife, and inoculated on obliquely-set blood-serum. Of ten blood-serum tubes inoculated in this way the author obtained always one, and in some several, pure cultivations of tubercle bacilli. In the rest of the tubes impurities appeared owing to the development of germs, which at $37^{\circ}\cdot5$ and on blood-serum overpowered the tubercle bacilli.

From the fluid contents of phthisical cavities, of course, better results are obtained, as this material contains not only more bacilli but less impurities.

(2) Preparing Objects.

New Method of Preparing Sections of Teeth and Bone, to demonstrate the hard and soft tissues in combination.‡—Mr. A. Hopewell Smith writes:—"Immerse a newly extracted tooth in Müller's fluid for three to four weeks, and remove to spir. vini rect. for ten to twenty days. Alcohol (84 per cent.) may be used instead of Müller's fluid. Remove, wash in water, and seal up apical foramen with collodion. Place tooth in 15 ccm. of following solution:—HCl, 12 parts; HNO₃, 30 parts; aq. dest., 108 parts. Take 12 ccm. of 10 per cent. solution of HCl, and at end of fifteen hours add 1·5 ccm. of HNO₃, and at end of forty-eight hours add 1·5 ccm. of HNO₃ from commencement

* Canadian Record of Science, 1892, pp. 19-28 (1 pl. and 5 figs.).

† Centralbl. f. Bakteriöl. u. Parasitenk., xi. (1892) pp. 233-4.

‡ Trans. Odont. Soc. Gt. Britain, xxiv. (1891) p. 20.

of immersion in acid solution. Remove tooth (molar) at end of seventy-five to eighty hours, and wash in solution of lithium carb. (5 grm. to an ounce) for half an hour. Wash thoroughly with distilled water. Divide tooth by razor into several pieces, and wash again in water. Place each piece in gum mucilage (B. P.). Leave in mucilage twelve to fifteen hours. Transfer to stage of freezing microtome, cut, wash sections, and stain with orange-rubine, or gold chloride, or borax-carmin, or Weigert's solutions. Dehydrate in absolute alcohol three minutes, clear in cedar oil one and a half minutes, and mount in Canada balsam."

Investigation of Brain of Marmoset Monkey.*—Dr. C. E. Beevor, who has studied the fibres of the cingulum and the corpus callosum and fornix in the Marmosets, put the brains direct into a 3 per cent. solution of bichromate of potassium, where they were hardened from two to four months, and in one case for twelve. After hardening the brain was imbedded in celloidin and cut into sections by Schanze's microtome. Weigert's hæmatoxylin method, or Pal's modification thereof was used for staining. The sections were dehydrated by absolute alcohol, clarified by oil of cloves or origanon oil, and mounted in Canada balsam. The advantage of origanon oil over oil of cloves is that it does not dissolve out the celloidin, which is thus able to hold together the finer parts of the section, and prevent it from falling to pieces in the process of clarifying. The objection to it is that the sections do not remain perfectly flat. To obviate this some of the sections were dehydrated on the slide, the absolute alcohol was run off without disturbing the sections, which were then clarified by adding origanon oil. When this was completed the oil was run off, and oil of cloves was carefully added. This was run off after dissolving the celloidin.

Some of the sections were cut after imbedding in paraffin. The brain was hardened in methylated alcohol, put for two weeks in a 3 per cent. solution of bichromate of potash, washed in water and in methylated alcohol, and put direct into Weigert's hæmatoxylin for three or four days.

Preparation of Eggs of American Alligator.†—Mr. S. F. Clarke carefully removed the shell and its membrane from nearly half one side of the egg; the contents were then poured out on to the left hand, and the thick white at one end cut off with the scissors. The egg is then replaced in the shell with the germinal pole, still covered with white, uppermost. The white is next cut off as completely as possible from this end. The egg is now set on end, and a sharp-edged lifter is used to press out on either side incisions made with sharp-edged scissors. By this means the portion of the blastoderm which contains the embryo, and measures from 12 to 15 mm., is separated from the rest. The embryo is treated with Kleinenberg's picric for sections, or chromic acid for surface study.

Preservation of Tadpoles.‡—Mr. G. A. Boulenger recommends the collector of tadpoles to provide himself with small test-tubes half-full

* Philosoph. Trans., 182 B (1892) pp. 137-8.

† Journal of Morphology, vi. (1891) pp. 202-3.

‡ Proc. Zool. Soc. London, 1891 (1892) p. 599.

of weak spirit; the tadpoles, when taken out of the fishing-net, should be dipped head foremost in the tube. On reaching home the liquor should be at once changed to spirit 40 over proof, and this must be changed daily till it ceases to be strongly coloured. This mode of treatment preserves the natural shape of the tadpole, and the delicate caudal crests do not shrivel. Tadpoles should never be allowed to remain out of the fluid, as they shrink very rapidly. Chromic acid is not to be recommended, as it renders the specimens too brittle for ordinary study.

Preservation of Invertebrates in a State of Extension.*—Herr T. Tullberg was guided in his researches by the *a priori* consideration that, as sea-water contains several salts in definite proportions, it was probable that marine animals would not contract if one was to increase the proportion of one of the salts of the water; for the animal is already accustomed to these substances, and, on the other hand, it might have a toxic effect. Experimenting with *Actiniæ* (and especially with *Actinoloba dianthus*) he found that chloride of sodium had no effect, but with sulphate or chloride of magnesium the Actinian expanded its tentacles, and, after a certain time, did not contract at all when its tentacles were pinched.

It is first necessary to get an Actinian into a state of expansion; this may be done by leaving it for some time, even twenty-four hours, in a vessel of sea-water. The quantity of water must be measured so as to know the percentage of salt which is to be added. These precautions having been taken, a 33 per cent. solution of chloride of magnesium is added until the vessel contains 1 per cent. of the salt; thus for one litre of sea-water 30 ccm. of the solution must be added. The addition should be made slowly, or even intermittently; but it must be effected within half an hour. Thirty minutes later the animal will be found to be anæsthetized. As a matter of fact only the exterior of the animal will have lost its sensibility. The animal must now be killed; if the animal be inundated with alcohol, concentrated chromic acid, or Perenyi's fluid the result may be satisfactory for anatomical or histological purposes, but the specimens will not be fit for exhibition in a museum. If the fluids are added slowly, better results will be obtained. With chromic acid the following procedure may be adopted:—a tube with a funnel is plunged as far as the bottom of the vessel in which the animal lies, and a .1 per cent. solution of chromic acid is slowly and intermittently added. If the animal begins to contract during the operation, it must be stopped for a short time. The addition of acid must go on until the chromic acid is in the proportion of .3 to .5 per cent. of the total liquid. If the animal does not contract when this solution is added, the dose of chromic acid must be increased till the proportion is .5 per cent.

The results of this method are very satisfactory, save that there is a decrease in the volume of the animal. Sections of the tentacles showed that the cells were not attacked by the substances employed. Various animals have been experimented on. The author has applied this process to terrestrial and fresh-water Invertebrates, and finds that chloride

* Arch. Zool. Expér. et Gén., x. (1892) pp. xi-xiv.

of magnesium completely anæsthetizes them; it is well to use rather stronger solutions (about .4 per cent.) for them.

Observation of Blood of *Astacus*.*—Mr. W. B. Hardy obtained the blood of the Crayfish by aid of a glass pipette drawn out to a fine point and pushed through the soft skin which joins the dorsal portion of the cephalothoracic shield to the tergum of the first abdominal appendage. The pipette is fitted with a strong india-rubber bag, by the aid of which fluid may be sucked up into the tube. The skin is stretched by pushing down the abdomen of the Crayfish, and the point of the pipette is inserted from the side and horizontally so as to avoid injuring the heart and superior abdominal artery. A drop or two of blood being sucked up, the abdomen is quickly bent upwards so as to mechanically close the tiny aperture. A blood-clot will soon form, and the Crayfish may be replaced in the tank without any further loss of blood.

Permanent preparations may be made by inverting a drop of blood over a 2 per cent. solution of osmic acid; after 15 minutes the blood can be stained and mounted in glycerin or balsam. A reagent of the very greatest value in the study of the corpuscles is iodine.

Study of Cutaneous Glands of Crustacea.†—M. M. Ide fixed small marine species, such as *Vibila* or *Phronima*, by plunging them entire into Kleinenberg's solution, picrosulphuric acid, or 70 per cent. alcohol. With larger species, such as *Asellus* or *Oniscus*, the head was cut off and plunged in water saturated with corrosive sublimate or Gilson's solution (acid sublimate). For the glands of the urostyle of *Oniscus*, which are very difficult to reach, the ends of the urostyles must be cut off, and Gilson's solution injected into the body of the animal till it escapes by the cut extremities; the caudal portion must then be cut off with scissors and left for ten minutes in a bath of the fixing solution. Sections should be coloured on the slide either with alum picrocarmine alone or by it, followed with picric acid or watery blue carmine.

Study of Compound Eyes of Annelids.‡—Mr. E. A. Andrews macerated the eyes of Annelids in Bela Haller's liquid, in potassium bichromate, and in sea-water containing a small amount of sulphuric acid; the last method was found very useful. The staining reagents used were Mayer's acid carmine, Czokor's cochineal, and methyl-green. Sections were stained with Kleinenberg's hæmatoxylin, and Grenacher's fluid was used for depigmentation.

Examination of Ciliated Organs of Hirudinea.§—Prof. H. Bolsius has, in his general study of the segmental organ, chiefly employed the method of serial sections; these, it is to be observed, were not made on extirpated organs, but on entire individuals. This is the most advantageous method, as the organs are too delicate for ordinary dissection. In teased preparations the best staining agent was found to be methyl-green.

Preparation of Echinoderms.||—Mr. G. W. Field recommends the following method of preparing large starfishes, such as *Oreaster*. Kill

* Journal of Physiology, xiii. (1892) pp. 165-6.

† La Cellule, vii. (1891) pp. 352-3.

‡ Journal of Morphology, v. (1891) pp. 272-7.

§ La Cellule, vii. (1891) p. 296.

|| John Hopkins Univ. Circ., xi. (1892) p. 84.

by immersion in fresh water, at 35°–40° C., for an hour or two. Remove as much as possible of the soft parts. Immerse for any convenient time in alcohol in which corrosive sublimate is dissolved. Dry very quickly in the hot sun. After thorough drying, the normal colours can be reproduced by means of water colours with very good and permanent results.

Satisfactory specimens of *Diadema setosum* are particularly difficult to procure, on account of the delicacy and fragility of the spines. Thrust a stout sharpened wire through the anal membrane as the creature lies in his natural position in the water; when detached from the bottom, push the wire through and make a loop. Suspend the animal for 15 minutes in warm fresh water, and in 1 per cent. chromic acid solution in a large vessel; wash in several changes of fresh water after using chromic acid; place for an hour or two in weak alcohol, then for a day or two in 10 per cent. solution of corrosive sublimate in strong alcohol. Dry rapidly in the sun, suspended by the wire. If the drying be quickly done, the spines will retain nearly their normal position. This process, with modifications, can be applied to other Echinoids.

Alcohol specimens should be killed by immersion for a short time in 0.1 per cent. chromic acid solution, or in warm fresh water; then place in weak spirit, and finally in 80 per cent. alcohol. For histological purposes Flemming's chrom-osc-acetic solution gives good results. After hardening recalcify in 70 per cent. alcohol to which a few drops of hydrochloric or picronic acid has been added.

Methods of Examining Zoanthæ.*—Prof. A. C. Haddon and Miss A. M. Shackleton examined specimens of Zoanthæ which had been preserved in alcohol. When a sufficient quantity of strong spirit is used this answers very well. They stained the objects alive in borax-carminc, imbedded them in paraffin, and cut them with a rocking microtome. The unincrustated and some of the incrustated genera are very easy to cut. As a rule, the incrustations from coral seas are calcareous, and admit of being readily dissolved away with nitric acid.

Mode of obtaining Sections of Ovules.†—Herr J. W. Moll recommends the following method of making sections of ovules:—The ovules (*Fritillaria imperialis*) are placed for twenty-four hours in Flemming's solution; after washing with water they are transferred to alcohol of about 95 per cent., and are then dissected in alcohol under the lens. The parietal protoplasm of the embryo-sac is removed and placed in a drop of celloidin and solidified, and the slide is then plunged in alcohol of 95 per cent. The thin plate of celloidin containing the material for the sections is then detached from the slide and placed in alcohol of 95 per cent. coloured by gentian-violet for an hour, next in a mixture of 6 per cent. of oil of marjoram and 1 per cent. of alcohol (95 per cent.), and then in pure oil of marjoram until it becomes transparent. The plate of celloidin is imbedded in paraffin and cut into thin sections, which are mounted in Canada balsam or dammar-resin after staining with gentian-violet. The object is to obtain the nuclei in process of division.

* Scient. Trans. Roy. Dublin Soc., iv. (1891) p. 611.

† Bot. Jaarb., xx. (1890) p. 325. See Bonnier's Rev. Gén. de Bot., iv. (1892) p. 81.

(3) Cutting, including Imbedding and Microtomes.

A new Method of Using Celloidin for Serial Section Cutting.*—The following method is recommended by Mr. H. C. Bumpus as having several features which make it preferable to the ordinary methods of section-cutting:—It allows a perfect orientation; the entire object is visible during the process of cutting; yolk-bearing eggs offer no serious difficulty; sections of large area and of unusual thinness are easily secured; crimping and curling during the process of clearing are avoided and the sections may be readily arranged in series.

The object is first stained *in toto*, dehydrated, infiltrated with thin, medium, and thick celloidin or collodion (Squibb's flexible collodion rendered thick by evaporation is excellent) and finally placed in a paper tray filled with the thick collodion. In a few moments a film will form over the exposed surface of the collodion, when the paper tray with its contents is thrown into a jar of strong chloroform, in which, after a few hours, the collodion becomes quite hard.

The tray is now taken from the chloroform, and, after the paper has been removed from the hardened block, the collodion with its enclosed object is placed in a vial of white oil of thyme, or some other similar oil. If the block of collodion is not large, in a few hours it will become as clear as glass, the stained object appearing as if suspended in a transparent fluid.

For the process of orientation, the block of collodion may now be taken from the oil, placed in a watch-crystal, and, after covering with the oil of thyme, examined with a lens, or, if more desirable, with a compound Microscope. The side of the block that is to be attached to the object-holder of the microtome is now selected, wiped dry of the oil, and immersed for a moment in ether, and then smeared with thick collodion. The object-holder, a block of wood rather than cork, is smeared in the same way, and the two collodionized surfaces are brought together. The holder and collodion block are now immersed for a few minutes in chloroform, or long enough for them to become firmly united.

The preparation is now screwed between the jaws of the object-carrier of the microtome and covered, by means of a camel's-hair brush, with oil of thyme. The microtome knife is flooded with the same oil. This oil, which takes the place of alcohol usually used, has the advantage, because of its lubricating property, of not only permitting thin sections to be cut, but its slow evaporation allows one to leave work at any time for minutes or even hours without the object being injured.

After a few sections have been cut from the block of collodion, the relative position of the plane of the knife to the axis of the object can be definitely established. There is no difficulty in orienting small Arthropod embryos by simply examining the object and plane of cutting at this time with a compound Microscope; the segments, appendages, and even nuclei are as clearly shown as if mounted in balsam. The object, satisfactorily oriented, is now cut and the sections at once transferred to the slides, covered with balsam and mounted, or, if they are not immediately needed, they may be kept indefinitely in a vial of the oil.

* Amer. Nat., xvi. (1892) pp. 80-1.

If the sections are to be arranged in "series," they are simply placed upon a slide one after the other, care being taken not to flood the slide with oil but to keep it quite dry. After the sections are arranged, the slide is tilted up to allow the excess of oil to drain away, fifteen minutes generally being sufficient. Balsam is now placed on the sections and a warm cover is allowed to gently fall over the series, no section of which ought to leave its place.

The above method is especially useful in the preparation of larger yolk-bearing eggs.

(4) Staining and Injecting.

New Method for staining Central Nervous System.*—The pieces of nervous tissue are, says M. Lichen, to be placed for five weeks in a mixture of equal parts of 1 per cent. chloride of gold and 1 per cent. corrosive sublimate. The pieces are then sectioned in dilute lugol solution (1/4).

The medullated or non-medullated fibres, the nerve-cells, and the neuroglia-cells are coloured blue. In the ganglion-cells nucleus and nucleolus were clearly differentiated.

Methods of staining the Axis-cylinder in Sections of Spinal Cord.†—For staining spinal cord Herr Schmaus adopts the following modification of Gierke's method:—1 gm. of carminate of soda, 1/2 gm. of nitrate of uranium, and 100 gm. of water are heated for half an hour and filtered when cold. The sections are placed for 15 to 20 minutes in the staining fluid and then washed with water.

The tissue must have been previously hardened in Müller's fluid. By this method the axis-cylinders are perfectly stained while the celloidin is unaffected.

In another method employed by Kronthal, carmine is used with great success. A saturated solution of carmine is made in ammonia, and the solution, merely covered with a piece of tracing paper, is allowed to stand for a week. The supernatant fluid is then decanted to a well-stoppered bottle and left for four weeks.

In a mixture of 10 drops of this fluid and 100 ccm. of distilled water the sections are placed for 24 hours, after which they are washed with water for 24 hours. The older the solution is the greater its staining power, due to the formation of the carbonate of carmine, becomes. It does not stain the celloidin.

A third method recommended by Schmaus is to stain the axis-cylinders with English blue-black. The solution consists of 1/4 per cent. blue-black to 50 per cent. spirit with a little picric acid added. After an immersion of one hour the sections are washed and mounted.

Examination of Nerve-centres by Iodide of Palladium Process.‡—Prof. G. Paladino states that his process of studying the central nervous system consists in impregnation by chloride of palladium in a 1 per 1000 solution, and formation of iodide of palladium by the reaction of iodide

* Neurol. Centralbl., 1891, No. 3. See Bull. Soc. Belge de Microscopie, xliii. (1891) p. 13.

† Münchener Med. Wochenschr., 1891, No. 8. See Bull. Soc. Belge de Microscopie, xviii. (1891) pp. 11-12.

‡ Journ. de Micrographie, vi. (1892) pp. 77-8

of potassium in a 4 per 1000 solution. Immersion in chloride of palladium may be continued for two or three days or even weeks without danger, and even with advantage, if the solution be renewed; but immersion in iodide of potassium must not be for more than one or two hours. Those who have used these reagents speak highly of them.

Useful Modification of Gram's Method.*—Dr. Eng. Bothin says that many of the well-known inconveniences incidental to Gram's method may be obviated, and the staining of the bacteria much improved by washing the preparation, section or cover-glass, in anilin-oil-water after it is removed from the gentian-violet solution, and before it is immersed in the iodine solution.

Genevan Reagent.†—Under this name (*réactif genevois*) Prof. R. Chodat recommends a double staining reagent which he finds useful in the differentiation of vegetable tissues. It consists of a slightly alcoholic and ammoniacal solution of congo-red (2 per cent.) and chrysoidin (2 per mille). The section is first decolorized by eau de Javelle, and then immersed in this reagent for a few seconds, when a beautiful double or triple staining is obtained. The cellulose membranes are coloured rose, while the lignified or cutinized cells take a yellow tint varying according to the degree of hardening of the membranes.

(5) Mounting, including Slides, Preservative Fluids, &c.

Fixation and Preservation of Compressed Objects.‡—Mr. N. A. Cobb suggests the following method for fixing, staining, and mounting compressed objects. The object—e. g. a dipterous larva or a Nematode—is compressed between two small cover-glasses of the same size; the amount of compression must be regulated by means of two hairs, or, better, two pieces of spun glass. The animal should be laid on one of the covers in a drop of water too small to entirely fill the space between the covers. When the other cover is laid on and the object is correctly compressed and arranged, the covers must be fixed in place. This is done by moving the two covers to the edge of the slide by means of a needle, and touching first one side of the pair, then the other side, with the wick of a wax taper or candle which has just been extinguished. The melted wax serves to cement the covers together, and they may be afterwards handled without much risk.

The covers, thus united, must be allowed to lie until all or nearly all the water between them has evaporated. To further treat the animal, take an elongated piece of quill or other similar elastic non-metallic substance, and make in it two cuts in such a way as to convert the quill into a compressing machine; into the compressorium so made insert the covers. To fix the object, take hold of the quill and place one edge of the covers in the fixing fluid, which will run in by capillary attraction. The author recommends that the whole apparatus be made so small as to be readily introduced into the object-box of his differentiator.

* Centralbl. f. Bakteriöl. u. Parasitenk., xi. (1892) pp. 231-2.

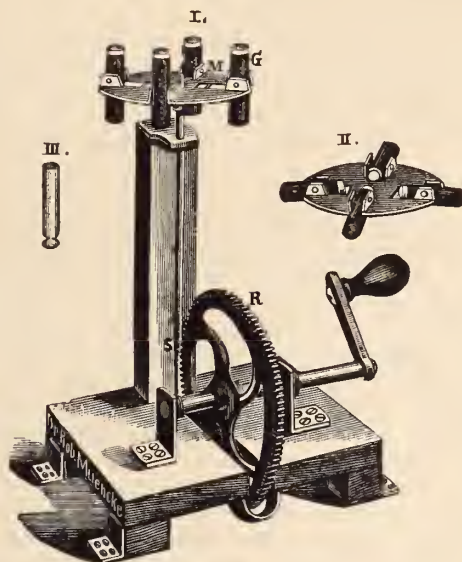
† Arch. Sci. Phys. et Nat., xxvi. (1891) p. 500.

‡ Proc. Linn. Soc. N.S.W., vi. (1891) pp. 143-6 (3 figs.).

(6) Miscellaneous.

Muencke's Centrifugal Machine for Bacteriological and Clinical Examination Purposes.*—Dr. R. Muencke has devised a centrifugal machine (fig. 56) for bacteriological and clinical purposes. The machine, which, as the accompanying illustration shows, is worked by hand, is intended to avoid the waste of time incident to sedimentation of fluids

FIG. 56.



containing elements of very small specific gravity. By the aid of this apparatus oxalic acid crystals, red discs, albumen, and even micro-organisms, can be demonstrated under the Microscope in a moment, and for the examination of the urine and of any exudation it is of especial service.

The machine, depicted $1/5$ the natural size, merely consists of a plate which is caused to revolve by means of a rackwork and wheel. One turn of the wheel causes the plate to revolve 50 times. Fig. II. shows the wheel rotating, and fig. III. a glass tube which is used to contain the fluids.

* Centralbl. f. Bakteriologie u. Parasitenk., xi. (1892) pp. 85-7 (3 figs.).

PROCEEDINGS OF THE SOCIETY.

MEETING OF 20TH APRIL, 1892, AT 20, HANOVER SQUARE, W.,
THE PRESIDENT (DR. R. BRAITHWAITE, F.L.S.) IN THE CHAIR.

The Minutes of the meeting of 16th March last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was read, and the thanks of the Society were given to the donors.

	From
12 Slides of Deep-sea Deposits from the Eastern Archi- } pelago }	Surgeon P. W. Basset- Smith, R.N.
3 Slides of sections of <i>Liriodendron</i> }	Prof. D. P. Penhallow.

Mr. A. W. Bennett called attention to some slides which had been received from Prof. Penhallow, of Montreal, who sent them to illustrate a new method of labelling which he had found to be very useful, and which he thought was an improvement upon the ordinary method. Instead of writing upon the usual paper label, his plan was to write directly upon the glass and to cover the writing afterwards with a thin coating of Canada balsam, which made it quite permanent. The slides sent were merely intended as samples of the method of labelling; those who saw them would, no doubt, agree as to the neatness of their appearance; nothing, however, was said as to the material with which the writing was made.

Dr. W. H. Dallinger said there would be no difficulty in preparing a suitable ink for this purpose, but he thought that as ordinary ink ran so freely upon the surface of glass, some special kind would be necessary for this purpose.

Prof. F. Jeffrey Bell said that the Council had, since their last meeting, received notice from their landlords that the rates would no longer be paid, so that they were now free to act upon the terms of the new arrangement. One consequence of this would be that in future the rooms of the Society would be open for the use of Fellows every Wednesday evening from 6 to 10 p.m., as at King's College, from November to June, it being understood, however, that if there were no persons present on any occasion at 9 o'clock, the rooms would be closed at that hour. Of course it would be understood that this order would take effect at once, and that therefore the rooms would be opened for the first time on Wednesday evening next, the 27th inst.

Mr. F. Chapman submitted the second part of his paper "On the Foraminifera of the Gault of Folkestone," part i. having been read at the meeting in October 1891. The paper being chiefly descriptive of the forms exhibited in the room, was for that reason taken as read, it being understood that it would appear in the Journal fully illustrated.

Surgeon P. W. Bassett-Smith's paper "On the Deep-sea Deposits of the Eastern Archipelago" was read by Prof. Bell. H.M. surveying ship 'Penguin,' to which Surgeon Bassett-Smith was attached, made a passage during the later part of 1891 from Port Darwin, North-west Australia, through the Arafura, Banda, Celebes, Sulu and China Seas to Hong Kong, calling at the following places *en route*:—Dammar Island, Amboyna, Ternate, Samboangan, and Manila. A continuous and close line of soundings was taken through the whole passage, the deepest water being 2880 fathoms, in the Banda Sea; in almost every instance specimens of the bottom were obtained. They consisted mostly of "green muds," with a few "blue" and "brown muds" in the deeper parts. The definition of "green mud" is a very wide one; broadly it may be divided into that in which calcareous organisms, chiefly *Globigerina*, predominate, and that in which the tests of Radiolarians have taken their place; this latter condition was almost always present in "brown muds." The inorganic materials were either fine quartz sand in the deeper and more distant positions, or, as the coast was approached, argillaceous matter, together with sponge spicules and small shells. In places the material was typically volcanic, as in the upper part of the Banda Sea and among the Molucca Islands and along the coast of Luzon. Only two specimens of pure *Globigerina* ooze were obtained, both in the Molucca Sea, one in 1885 fathoms, and the other in 697 fathoms. It seems that in the deeper parts of the seas the bottoms consist of Radiolarian muds, and the shallower parts of *Globigerina* muds, the line being roughly drawn at 1500 fathoms. In almost every case over 2000 fathoms the siliceous organisms were undoubtedly most abundant. The paper was illustrated by a track chart and by twelve mounted specimens of the deposits.

A note was read from Dr. E. Giltay "On the Use of the Camera Lucida in drawing Bacteria," in which he recommended the illumination of the drawing by a powerful lamp, and the testing of the drawing by a slight change in the position of the paper, so as to compare side by side the drawing made and the camera lucida outline. Dr. Giltay stated he had succeeded in drawing objects magnified 2500 times.

Dr. Dallinger said it did not appear that there was anything described in this paper but what had already been done, and was well known to all who were in the habit of making drawings, except, perhaps, the suggestion as to the mode of making the comparison between the drawn image and the object. The idea of arranging the illumination so as to make the point of the pencil clear whilst drawing was one which had been carried out for the last twenty years at least.

Mr. A. D. Michael said they could all echo what Dr. Dallinger had said with regard to the methods of drawing with the camera lucida. He did not, however, see that it was at all necessary to put the lamp so near as to endanger the head of the person who was drawing; he was himself always in the habit of using a second lamp whilst making drawings in this manner, but used his stand condenser to throw the required light upon the paper from the lamp placed at some distance on one side. The method of comparison suggested might be unusual, but he thought it was open to some objection on the ground of the distortion

which it would be likely to produce; but as every one who made drawings in this way adopted some method of comparison, he did not think there was very much in the communication which could be noted as being new.

The President thought perhaps the great amplification might be exceptional.

Mr. Michael said it was unusual, but it had often been done.

Prof. Bell said they had just received a note from Mr. J. C. Wright, of Edinburgh, on some Rotifers which he had found attached to a newt. The communication was accompanied by some drawings, which were, unfortunately, not sufficiently clear to render it by any means conclusive that what he had found was a Rotifer; it was, in fact, difficult to say exactly what it was, though probably it might prove to be a specimen of *Vorticella*.

Prof. Bell said they had also received a communication from Mr. F. R. Dixon-Nuttall, who sent a *Furcularia*, with a description which might show that it was a new species. It had only just come to hand, so that there had been no time to examine it; but he suggested that they could not do better than to send it to Dr. Hudson, with a request for his opinion upon it.

Mr. W. M. Osmond's paper, in which he described a simple apparatus for adapting a camera for the purpose of photographing objects direct from the Microscope, was read by Prof. Bell. It was illustrated by photographs showing the arrangements described, for which the merits of steadiness, cheapness, and compactness were claimed.

Dr. Dallinger said this arrangement was, no doubt, simple, and it would very likely be useful for very low power work, but he doubted if it was likely to be of value if applied to moderate or high powers. It appeared from the photograph to be clamped to the end of the camera and again to the pillar, with what was certainly a relatively long interval between the clamping-screws. Those who did work of that kind, especially with high powers, knew that it was of the utmost importance that they should have great rigidity between those two points, and, having regard to the structure of this apparatus, he should be afraid that it would be found that there was too much vibration in practice.

Mr. C. L. Curties thought it was certainly a very convenient form, but he should be sorry to have to use it for anything beyond a 1/2-in. objective, or with a magnifying power of over 100 diameters, feeling that with such a method of construction it would be impossible to get sufficient steadiness for use with higher powers.

The following Instruments, Objects, &c., were exhibited:—

Surgeon P. W. Bassett-Smith, R.N.:—Twelve Slides of Deep-sea Deposits, illustrating his paper.

Mr. F. Chapman:—Foraminifera, illustrating his paper.

Mr. W. M. Osmond :—Photographs of his Photomicrographic Stand.

Prof. D. Penhallow :—Three Slides of *Liriodendron*, illustrating his method of labelling.

New Fellows :—The following were elected *Ordinary Fellows* :—
Dr. George W. Cale, Jun., and Mr. Arthur B. Newiman.

MEETING OF 18TH MAY, 1892, AT 20, HANOVER SQUARE, W.,
THE PRESIDENT (DR. BRAITHWAITE, F.L.S.) IN THE CHAIR.

The Minutes of the meeting of 20th April last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Rafter, G. W., The Microscopical Examination of Potable Waters. pp. 160, 5 pls., 1 table, text illus. (12mo, New York, 1892) ..	The Author.
Squire, P. W., Methods and Formulæ used in the Preparation of Animal and Vegetable Tissues for Microscopical Examination, including the Staining of Bacteria. pp. vi., 93. (8vo, London, 1892)	"
Sternberg, G. M., Report on the Etiology and Prevention of Yellow Fever. pp. 271, 21 pls., text illus. (8vo, Washington, 1890) ..	"
On the Organization of Science. By a Free Lance. pp. 32. (16mo, London, 1892)	"

Prof. F. Jeffrey Bell said that several of these books had been received too recently to admit of any opportunity of becoming acquainted with their contents, but that by Mr. Squire, "On Methods and Formulæ for Staining Microscopic Preparations," looked as if it was likely to prove useful. Dr. Sternberg's book was accompanied by a note in which the author mentioned that he had previously forwarded a copy, but not seeing it noticed in the Journal, he feared that it might not have been received. As a matter of fact it was duly received, but the space at disposal in the Journal being limited, and the subject of the prevention of yellow fever being scarcely one which came within the scope of topics of microscopical interest, the book had not been commented upon. The book on the Organization of Science was apparently written by an enthusiast, and as it was sometimes useful to know what other people thought about ourselves, it might be of interest to read an extract giving the author's opinion as to the Royal Microscopical Society and its Journal. "This Society is doing splendid work, and plays an unique and highly important part in the organization of science. But it is not free from all taint of trespass and robbery, for its duomensual journal usually contains one or two anatomical or faunistic papers that belong to the province of the Linnean Society. (This Society also publishes in its Journal abstracts of papers on botany and zoology appearing in other journals. That such work should be done is indispensable; but it is by no means clear that the Microscopical Society should do it. *Prima facie*, one would expect this duty to devolve upon the Linnean

Society, just as the work of abstracting chemical papers is performed by the Chemical Society, whose journals thus consist (a) of their own Transactions, and (b) of abstracts from *all* other chemical journals. Since, however, according to the scheme sketched in the text, there is abundance of work for the Linnean Society, it is conceivable that the interests of science might be best served by the publishing of such abstracts being left to another organization, as at present.)”

Prof. Bell said they had received a communication from Mr. G. Morton as to some new collecting bottles which he was making for the use of the microscopists; and he had been asked in reply to send some samples to that meeting for the Fellows to see for themselves. These were placed upon the table for this purpose.

He had also a letter from the Secretary of the London Stereoscopic Company offering to place their rooms at the free disposal of any Fellows of the Society who might like to make use of them for the purpose of printing and finishing photographs from their own negatives.

Prof. Bell said it would no doubt be remembered that at their last meeting a drawing of a species of *Furcularia*, thought to be new, was sent by Mr. Dixon-Nuttall, and that it was decided to send it to Dr. Hudson for his opinion. Dr. Hudson had replied that from the description given he concurred in the opinion expressed by Mr. C. Ronsslet that it was *F. tenuiseta*, but he concluded his letter by saying that he was unable to offer to examine the living animal in consequence of the condition of his eyesight. This was the first intimation they had received of anything being amiss with Dr. Hudson in this respect, and Prof. Bell felt sure that it would be a matter of great regret to the Fellows of the Society to hear that such was the case.

Mr. J. C. Wright has written a letter to the Society to defend the statement made in his former communication as to his having found some Rotifers attached to the gills of a newt. It appeared that he and a friend had carefully searched for more Rotifers in a similar position, but had been unable to find any. Mr. Wright added some further remarks in confirmation of his former description, which did not appear, however, to affect the question as to the objects which he found being *Vorticellæ*.

Mr. R. T. Lewis read his paper “On the Process of Oviposition observed in a species of Cattle Tick,” the subject being illustrated by a coloured diagram and drawings. The tick itself, which formed the subject of the note, was also handed round for inspection.

The President thought they might congratulate Mr. Lewis upon the extremely interesting paper which he had just read, and also upon the lucid manner in which he had placed the subject before them.

Mr. A. D. Michael said that he could not add very much to what Mr. Lewis had told them in his paper on that particular subject, because, so far as he knew, the observation was entirely new, and he was not aware of any record of the process having been previously made. It

was a matter of old knowledge that *Ixodes* laid its eggs from the front part of the body; but the observations described in the paper had evidently been made under exceptionally favourable circumstances, and, so far as his knowledge went, they were perfectly novel. The seizure of the egg by the saccular arrangements and the coating of it with mucus by them was a thing which he believed had not been previously seen. As regarded the reference which had been made in the paper to *Ixodes ricinus*, he did not think it would be safe to conclude that the eggs were in that species laid in the same manner as that which had been described, because the vulva did not appear to be situated so far forward, but was nearly between the fourth pair of legs. On the other hand, it was of course true that the word *vulva* in the case of the Acarina was rather a vague term, because it was not always the same thing as the *bursa copulatrix*; but in the case of *Ixodes ricinus* it was between the fourth pair of legs, and, moreover, if Pagenstecher was right in his description, the ovaries led up to it. With a view to the printing of the paper he might remark that the word "head" as there used was somewhat misleading, because in this class of creatures there really was no head in the sense in which they understood the term to apply to the head of an insect; but the whole of the movable organ commonly called the head was really the rostrum. In *Ixodes* it had somehow become the fashion to apply the expression rostrum to the projecting part containing the mandibles; this was, however, by no means the rostrum, but only a part of it, being in fact a maxillary lip formed by the fusing together in the central line of the two sheaths containing the mandibles. The lower portion was armed with a number of recurved hooks, and the upper portion was channelled to admit of the free movement of the mandibles. When these had made an incision in the skin the maxillary lip was pushed into the orifice, and the separation of the two portions caused the hooks to hold firmly. When the creature wished to release its hold, the two portions were pressed together, and the organ could be withdrawn; but if it was attempted to be torn out, the resistance of the hooks nearly always caused it to be broken off and left behind in the wound. The portions which were often called the rostrum—but which he had already explained were really the maxillary lips—were the representatives of the pedipalps in spiders, and the palpi mentioned were maxillary palpi, not labial. The subject of how to deal with these creatures was one of growing importance, because serious complaints were coming in from all parts of the colonies and elsewhere in warm climates as to the trouble which was being caused by them; at the present time this was especially so with regard to the West Indies, where the mischief they did was enormous.

The President inquired if it was not probable the mucus with which the eggs were covered was for the purpose of making them adhere to the hair of their hosts.

Mr. Michael said it was, no doubt, of use in attaching them to the grass amongst which the eggs were always laid. It seemed probable that during their early stages they were vegetable feeders, but that, when they were ready to mature, the female ticks transferred themselves to animals and then sucked blood, but before laying their eggs they dropped off upon the grass. Their capacity for absorbing blood

was almost incredible, but some idea of it might be formed from experiments made by Prof. Leidy, who collected a number which had not been fed, and weighed them, and then on weighing them again after being fully fed he found that they were more than 100 times heavier than when unfed.

Mr. E. M. Nelson made some remarks in further elucidation of his paper on "Penetration in the Microscope," showing that for his own sight the penetrating power was only $1/7$ th of that given by Prof. Abbe, whose myopic sight accounted for the difference of estimate. Photographs were shown in proof of the correctness of his contention, they having in themselves no focal depth.

Mr. Nelson also gave a short *résumé* of a note on the rings and brushes seen with the Polariscope—very beautiful effects, for the observation of which a petrological Microscope was generally thought to be necessary. This he showed was not essential, as what they wanted to see was not really a microscopic, but a telescopic object, so that all they had to do was to convert the Microscope into a telescope for the occasion, and this was readily done by placing an objective inside the tube of the instrument in the manner demonstrated.

Prof. Bell said that, as mentioned at their meeting in March, the Council had been considering the possibility of making arrangements for a *Conversazione* on a somewhat more extended scale than had been attempted of late. As it was obvious that their usual place of meeting was too restricted for the purpose, the Council were of opinion that it might be as well—to borrow a legal phrase—to change the venue, and in doing this they thought it might also be well to change in some measure the character of the visitors. Definite arrangements could not, of course, be made at present, but it was proposed to hold the *Conversazione* in the autumn in some of the rooms at St. James's Hall, and to issue cards of invitation to admit ladies also. The probable date would be November 30th, and, as ladies were coming, he was sure that Fellows of the Society would show themselves equal to the occasion by bringing for exhibition the most interesting objects they could find.

The following Instruments, Objects, &c., were exhibited:—

Mr. R. T. Lewis:—Living Larvæ of Cattle Tick, recently hatched. Mouth Organs of same, multiplied by 400.

Mr. E. M. Nelson:—Photographs, illustrating his paper.

Mr. C. Rousselet:—*Asplanchna priodonta*, mounted.

New Fellows:—The following were elected *Ordinary Fellows*:—Messrs. Frederick Chapman, Frederick Richard Dixon-Nuttall, and Prof. J. W. Hoffman.

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The Society was established for the promotion of Microscopical and Biological Science by the communication, discussion, and publication of observations and discoveries relating to (1) Improvements in the construction and mode of application of the Microscope, or (2) Biological or other subjects of Microscopical Research.

It consists of Ordinary, Honorary, and Ex-officio Fellows, without distinction of sex.

Ordinary Fellows are elected on a Certificate of Recommendation signed by three Ordinary Fellows, setting forth the names, residence, and description of the Candidate, of whom the first proposer must have personal knowledge. The Certificate is read at two General Meetings, and the Candidate balloted for at the second Meeting.

The Admission Fee is 2*l.* 2*s.*, and the Annual Subscription 2*l.* 2*s.* payable on election and subsequently in advance on 1st January annually, but future payments may be compounded for at any time for 3*l.* 10*s.* Fellows elected at a meeting subsequent to that in February are only called upon for a proportionate part of the first year's subscription, and Fellows permanently residing abroad are exempt from one-fourth of the annual subscription.

Honorary Fellows (limited to 50), consisting of persons eminent in Microscopical or Biological Science, are elected on the recommendation of five Ordinary Fellows and the approval of the Council.

Ex-officio Fellows (limited to 100), consisting of the Presidents for the time being of any Societies having objects in whole or in part similar to those of the Society, are elected on the recommendation of ten Ordinary Fellows and the approval of the Council.

The Council, in whom the management of the property and affairs of the Society is vested, is elected annually, and is composed of the President, four Vice-Presidents, Treasurer, two Secretaries, and twelve other Ordinary Fellows.

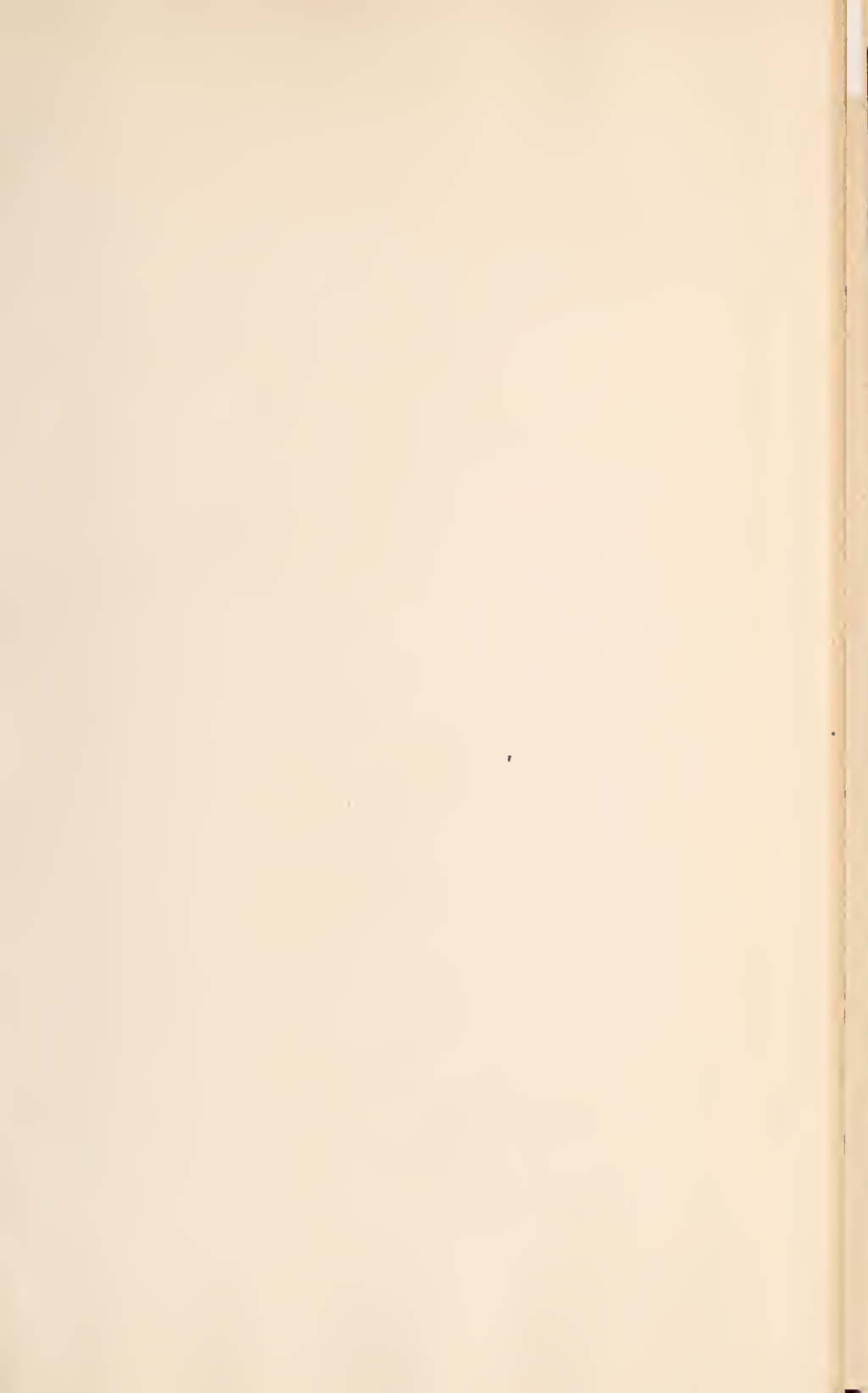
The Meetings are held on the third Wednesday in each month, from October to June, at 20, Hanover Square, W. (commencing at 8 p.m.). Visitors are admitted by the introduction of Fellows.

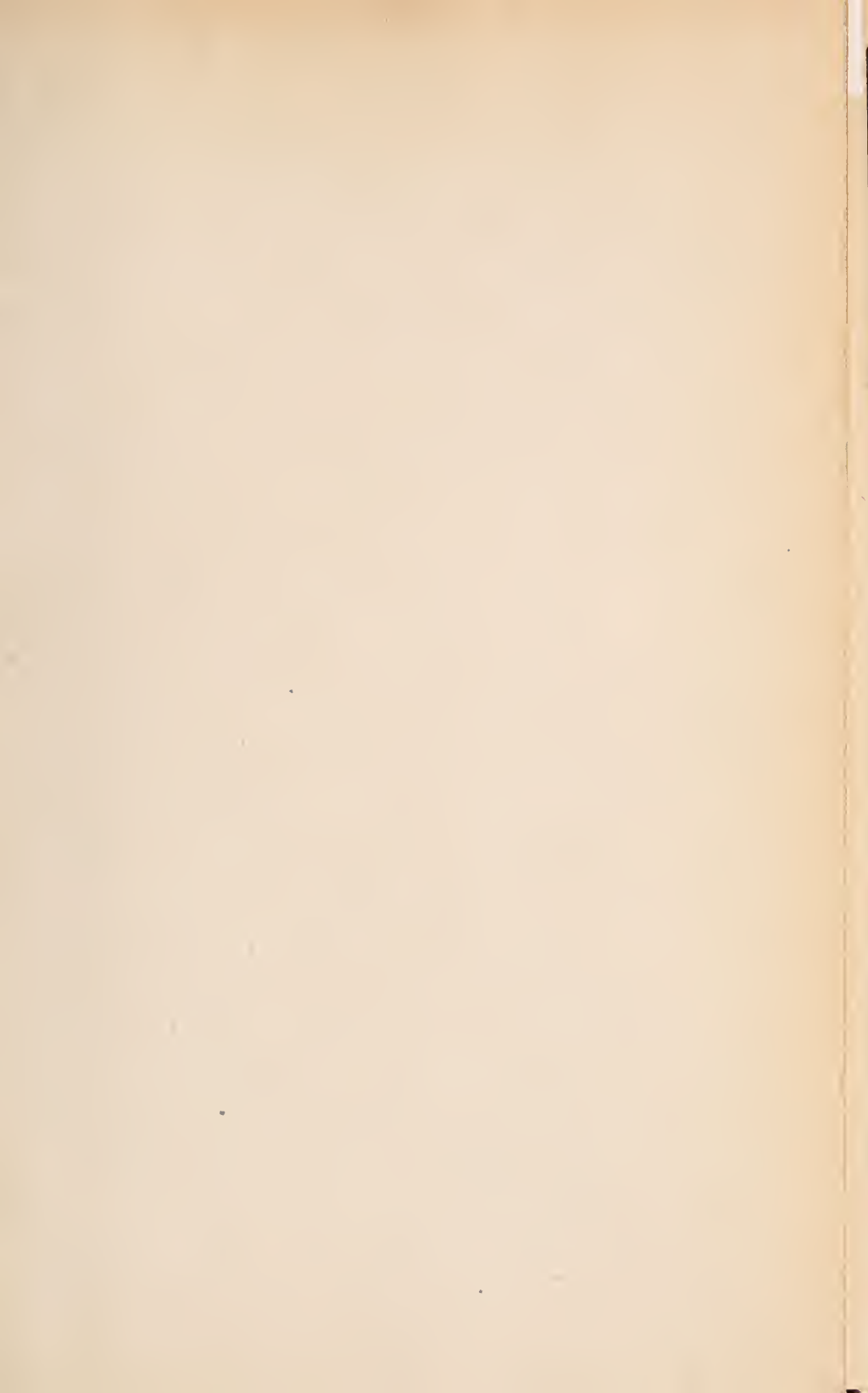
In each Session two additional evenings are devoted to the exhibition of Instruments, Apparatus, and Objects of novelty or interest relating to the Microscope or the subjects of Microscopical Research.

The Journal, containing the Transactions and Proceedings of the Society, and a Summary of Current Researches relating to Zoology and Botany (principally Invertebrata and Cryptogamia), Microscopy, &c., is published bi-monthly, and is forwarded post-free to all Ordinary and Ex-officio Fellows residing in countries within the Postal Union.

The Library, with the Instruments, Apparatus, and Cabinet of Objects, is open for the use of Fellows daily (except Saturdays), from 10 A.M. to 5 P.M., and from 6 to 10 P.M. on Wednesdays from November to June. It is closed for four weeks during August and September.

Forms of proposal for Fellowship, and any further information, may be obtained by application to the Secretaries, or Assistant-Secretary, at the Library of the Society, 20, Hanover Square, W.





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